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German Printing Telegraph

By Frank C. Perkins.

Various type printing telegraph systems have been brought out during recent years in America as well as in Europe, those in America, including the well-known systems of Phelps, Buckingham, Rowland and Murray, and those abroad, including Virag and Pollak, as well as the Baudot apparatus and the typewriter system of Siemens and Halske Actien Gesellschaft, of Berlin.

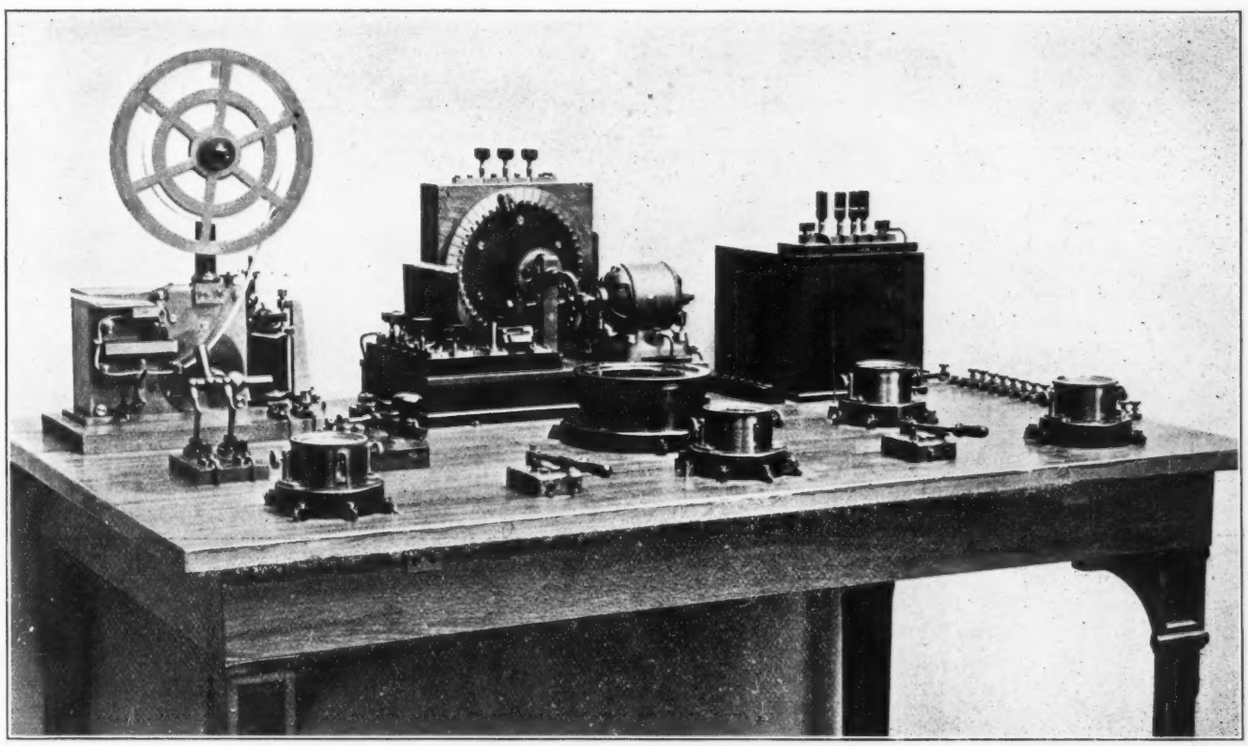


FIG. 3.—RELAYS AND ELECTRICAL INSTRUMENTS AND APPARATUS IF SIEMENS & HALSKE HIGH-SPEED TYPE-PRINTING TELEGRAPH SYSTEM.

In the apparatus of this new high speed type printing telegraph system recently developed at Berlin by the Siemens and Halske Actien Gesellschaft a sensitized paper strip capable of taking a photographic impression instantaneously is caused by a suitable motor driven mechanism to travel at an extremely high rate of speed very near to the periphery of a copper plate or disk which is also made to revolve at a speed of about 2,000 revolutions per minute by an electric motor. On this copper disk the letters and figures, about 45 in all, including the other characters and punctuation marks, are cut out and arranged spirally on the periphery. A small dark room or box is provided and on the opposite side to the paper strip is arranged a small spark gap which gives the necessary flashes for illuminating the paper through the lettered stencil disk, thus recording the letters and figures sent from the signaling station instantaneously upon the paper as it travels at its high rate of speed near the copper disk. At the signaling station or transmitting station on the long distance telegraph line the message is prepared on a perforated strip of paper by means of punches operated from a keyboard. The transmitting apparatus or sending machine then receives this perforated strip and positive and negative current impulses at the rate of 4,000 per minute pass to the line as the perforated strip moves at a high rate of speed through the sending machine. It is stated that this new high speed printing telegraph is capable of transmitting signals to extremely long distances at the high rate of speed of 2,000 characters per minute, tests having been made successfully on 1,000 kilometers of bronze wire and over 400 kilometers of iron wire without the least trouble. On the experimental line between Berlin and Frankfurt on

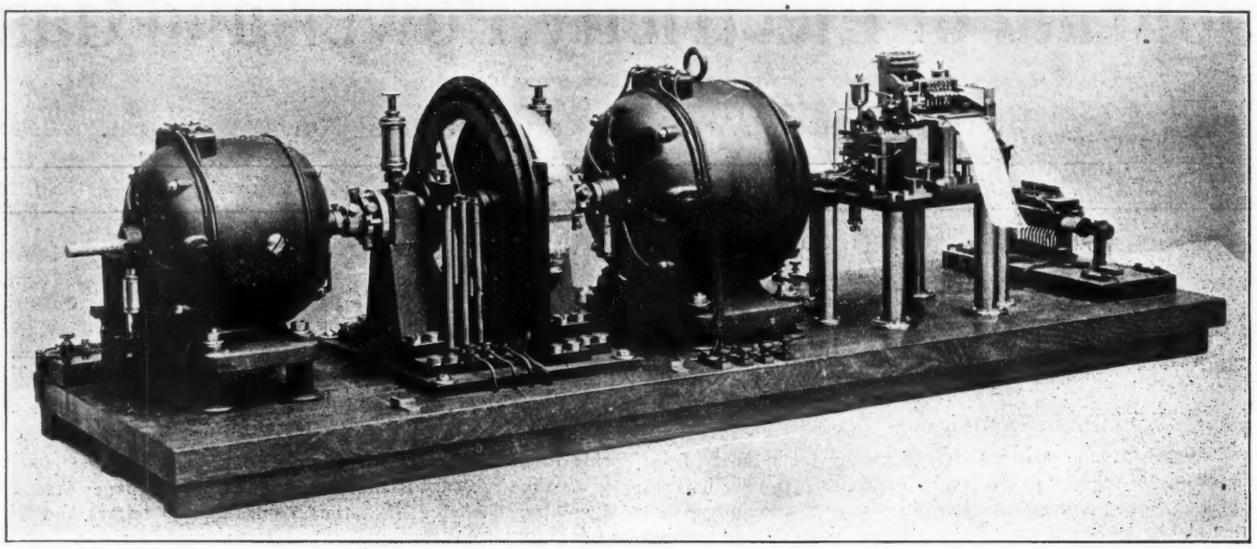


FIG. 1.—TRANSMITTING AND PERFORATING APPARATUS OF THE NEW SIEMENS & HALSKE HIGH SPEED TYPE-PRINTING TELEGRAPH SYSTEM.

the Main the pressure used was from 70 to 80 volts, the line being of bronze wire 3 millimeters in diameter. The bronze line of 1,000 kilometers length above mentioned over which the printed messages were sent was from 4 to 5 milometers in diameter.

As the positive and negative current impulses arrived at the receiving station they act upon the line relay, the two local contacts of which and the tongue are properly connected to revolving arms which make contact with metal strips or sectors on various disks. When the tongue is on these contacts, currents are permitted to charge the condensers and discharge them, producing the necessary sparks or flashes for illuminating the letters and recording upon the paper the characters sent from the transmitting station. Small electric motors are provided for driving both the receiving and sending machine. The various parts of the sending apparatus are all arranged on one shaft driven by the small motor, while the corresponding parts of the receiving apparatus are arranged on another shaft operated by a similar electric motor, it being absolutely necessary that synchronism is maintained which is more or less difficult without special devices being provided on account of the high speed maintained. As the maintenance of synchronism is most important a regulating relay is provided in circuit with a second and third arm on the charging disk. Now if the motor retards or accelerates there is an automatic adjustment of the resistance in the armature circuit, as well as in the field to suit the case, and the synchronism is maintained with accuracy and automatically.

The charging disk as well as the discharging disk and the contact disk of the receiving instrument are all mounted on the same base plate with the motor frame. The contact arms for each of the disks being arranged on the extended shaft of the rotor of the electric motor are rotated synchronously with the arms on the sending or transmitting instrument.

The accompanying illustrations, Figures 1, 2 and 3, show the transmitting, perforating and receiving apparatus and

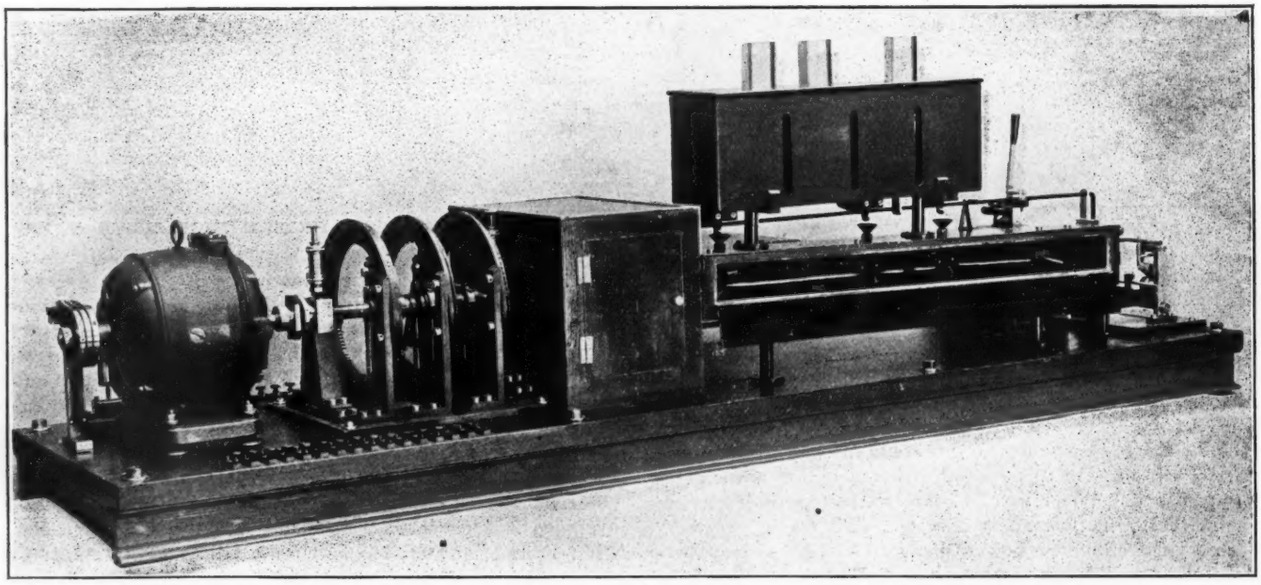


FIG. 2.—RECEIVING APPARATUS OF THE SIEMENS & HALSKE HIGH-SPEED TYPE-PRINTING TELEGRAPH SYSTEM.

relay of the Siemens and Halske high speed typewriting telegraph, while Figure 4 shows the perforated strip for sending and receiving message. The paper is from 300 to 400 meters in length, or about a quarter of a mile long, and will operate in the instrument continuously for about an hour.

This is a much more rapid system of type printing telegraph than that brought out by the Siemens and Halske Company in the form of a tele-typewriter, and installed in a central station in Berlin for transmitting telegrams to a large number of subscribers in different places at the same time. This machine was similar to the Baudet telegraphs and Hughes type printer, the telegraphing of the letters being effected by simply pressing down a key on the board corresponding to the signal desired. This typewriter keyboard had seven keys on each of four banks, one of which was a capital shift key and another a punctuation or figure shift key, while the remaining 26 keys when struck displaced the type wheel in a proper manner to transmit the desired signal. The same apparatus is used as transmitter or receiver without change, the figures or letters being printed in a similar manner to the Hughes printing telegraph.

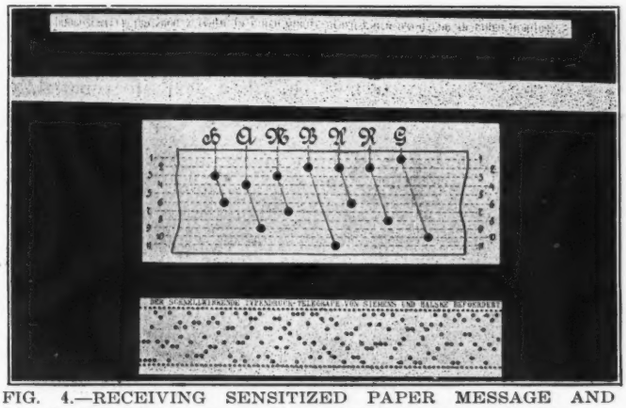


FIG. 4.—RECEIVING SENSITIZED PAPER MESSAGE AND PERFORATING PAPER FOR TRANSMITTING MESSAGES BY SIEMENS & HALSKE HIGH-SPEED TYPE-PRINTING TELEGRAPH.

A circle of letters and a circle of figures are arranged on the type wheel which is displaced automatically on its shaft by actuating the shift key so as to bring the circular rolls of letters or figures above the printing surface of the ribbon. When an ordinary key with a letter is pressed the type wheel of the transmitter is rotated just far enough to bring the desired letter in front of the paper, this same process occurring in the receiving apparatus. The type wheel impresses the character upon the paper which is moved upward after which it returns instantaneously and is moved along the distance necessary to receive the next character. Two records are thus produced at the same time, one at the receiving instrument and one at the sending instrument, the message being recorded at the instrument regardless of whether an operator is at hand or not, and if the operator is absent the message on the paper may be read later when he returns. This Siemens and Halske printing telegraph is particularly well adapted for supplying a large number of subscribers with news, messages or stock quotations, and is comparatively slow in speed and not at all to be compared with the new high speed Siemens and Halske type printing telegraph shown in the accompanying illustrations. The latter, of course, being capable of sending messages at an enormously high rate of speed, is specially well adapted for transmitting a large number of messages over a single line in a very short space of time.

ENGINEERING PERIODICALS AND THE CARD INDEX.*

Among the most valuable members of the engineering profession today are the moving spirits of the engineering press. Much matter of great value is regularly to be found in the current periodicals of a profession growing so rapidly and in so many directions as is mechanical engineering.

Books, monographs upon particular subjects, necessary as they are by their gathering within one cover all the required material of years and many places, and by their orderly classification, logical discussion, and evolving of principles, are, by very necessity of their production, always and inevitably behind the times. The reason for existence of the engineering press is to collect all recent valuable information—news, if you please—and present it weekly or monthly, less or more digested, to as large a circle of readers as possible. The American papers, representing special branches of the profession, far surpass in numbers and variety and excellence the like papers of the old world. Their general use proves that they have a most important place. With these may be grouped the published transactions of the many engineering societies and clubs. Unthinkingly or deliberately to neglect forming acquaintance with so great a source of engineering knowledge is not fitting for the engineer who has his own future to make in a country where ruts and old fashions are only for the failures.

Should one read, and preserve what he reads? To take knowledge into one's hand temporarily, and then not afterwards have that knowledge available for desired use, is as foolish as one to have seen a life preserver and not be able to find it at midnight collision.

The Card Index will obviate the difficulty, giving ready access to what has been read by its maker, recording information in the form best adapted to his professional needs and to his own peculiar habits of mind and memory, and following his own pet system. The speaker gave up the note-books ten years ago and commenced a card index or, as it is sometimes called, "Index Rerum" (Index of Things), making it really a written memory of everything which "might come in handy some time"; of reading, of experience, of oral information; engineering, household, athletic, religious; references to catalogues, drawings, clippings; lists, future plans, addresses—everything.

The making of a card index is a growth. The easiest way to get started is to read the papers with slips in hand and fountain pen or indelible pencil (ordinary purple copying) ready for use. Read an important article. At the top of a card place the subject of the article, very likely not the author's title of the article, but the subject that appeals to your type of mind after reading. Right here is the most difficult part of a card index. You are in danger of indexing an article on Compressed Air under C the adjective, when it should be under the noun A; or Blowers under B, when it should be under A as Air Blowers. Perhaps the most accessible guide for the inexperienced indexer is the table of contents of Kent's Mechanical Engineers' Pocket Book. In a discussion on card indexes on page 447 of the Proceedings of the American Society of Mechanical Engineers, Mr. Kent explains his method of general heads—e. g., to put everything relating to steam under Steam, as steam boilers, steam engines, steam pipes. The Railway Mechanical Engineer should follow the Car Builders' Dictionary, and the Index of the Master Mechanics' Association on page 67 of the proceedings for 1900, to be revised by a special committee for the proceedings of 1901. The Dewey decimal system, as expanded for engineering, was advocated in A. S. M. E., 1893, page 780, though the secretary of the A. S. M. E., in

*Abstract from an address by H. Wade Hibbard before the Student Society of Mechanical Engineers of Sibly College, Cornell University.

the proceedings for 1896, page 423, shows its limitations and recommends a different system as used in the library of the society and the engineering library of the Franklin Institute of Philadelphia.

Sometimes one is uncertain how to index some piece of information. Remember then that almost everything will have two parts—the thing and its function; and if the thing is the more prominent, catalogue it under the thing; or if the function, then under the function; but, and the following is called "cross-indexing," be sure and make out a card for the other and write on it: See the main card (giving its subject). A liberal use of cross indexing is no fault; one's mind does not always work on the same lines, and data might be buried even in a card index. Five years later one may not be able to recall just the one heading under which he indexed an article, but is sure to remember one out of the several headings of the cross indexing.

After the subject is written on the card, add the name of the paper, with year and page. The card is as yet practically worthless. Add a short description of the article with your opinion of its value or applications. Perhaps you can place upon the card all of the article that is of value. At least enough must show on the card to give the future searcher after information some discriminating idea of the article and whether it will pay to read it again to aid him in his engineering problem.

If the card is made out of information not in print, it should of course be full. A note book may, however, be needed, and in that case the card will refer to the note book by number or date upon the cover and the drawer number where finally deposited.

The card should be filed away in proper alphabetical order the same day it is made. No accumulation should be allowed, for it soon clogs the work and makes untold disorder. Later in life the busy engineer should handle his papers like his morning mail, reading them as soon as received, marking important articles and turning them over to an accustomed clerk for index cards and filing.

Where a number of technical papers are to be read each week or month, it becomes essential to learn how to get the cream without drinking all the pans of milk. It is out of the question to read them all thoroughly. Before attempting any reading an engineer should look them all over and note important articles to be read later if possible. In this way there is obtained a general idea of the contents of the papers and also of the relative importance to him of the articles noted. These are then carefully read in the order of merit, so far as time will permit. In this way, one will see and read many things of the first importance, whereas without such a preliminary glance through the papers, they might have been missed. Without going through papers, it cannot be known what they contain; while to begin and read as you go, results in using up all the time over matter which may be of little relative importance. One must, however, avoid the danger of being satisfied with the preliminary skimming; the thorough reading must follow.

Current engineering literature should not be left here without calling attention to the published volumes of index notes now so happily carried on monthly in the Engineering Magazine, 120 Liberty street, New York, the annual compilations of the same being assembled every five years in future volumes as in the past.

Interior classification, and several classifications just as easily, may be carried on simultaneously throughout the one card index, if found desirable in any business, by means of "tab cards." These are like the supplementary guides, but with numbers or other characters upon them, the projection at the top being raised in a particular place on a card for aech particular class, the tab cards being also of different class colors if wished. For example, all things made of brass may be indexed on yellow cards, while still placed in the proper alphabetical places of the things. If a tool index, every tool made of a "brand three" of steel will have 3 on the little projecting tab, and those tabs will show perhaps one inch from the extreme left throughout the entire index.

Yet remember, that at the start, the simplest scheme is the best, and the new maker of the card index will escape the danger of its toppling on account of its own weight of cumbersomeness while the foundation—the habit of adding to the list—is weak. The refinements may come later and for the special indexes, like that for tools.

Additional Uses.

What may be indexed? Everything. The advertisement clippings may be placed in numbered envelopes, they in numbered drawers, and indexed. Other clippings or pamphlets may be disposed of in the same way. Or material may be pasted in scrap books and the pages indexed in the card index. Some engineers prefer to tear apart all papers and file away only the valuable parts as indexed. Sometimes it is best to insert envelopes, open at the end, of the same size as the cards, into the card index; these envelopes to have subjects as though they were cards, small clippings being placed within. The books of one's own private engineering library are made far more useful by suitable contents references in one's card index.

Commercial literature, in the form of trade catalogues, forms a vast and growing collection of excellent technical and professional matter, which, while sometimes patial, yet is always fresh and is hence valuable in the experience of every engineer.

A systematic arrangement of catalogues (greatly facilitated if of standard 6x9 inches), giving instant reference to any one wanted, is a very important requirement of all who are designing, building or purchasing. Numbered, they are placed in numbered drawers and indexed with contents on the cards. It is usually possible, in addition, to group catalogues on the same subject into drawers together, if portions are torn apart which relate to different subjects. A cross-index of catalogue subjects is also advisable, unless the plan of the previous sentence is fully realized; and in this a card on one subject will refer the searcher to all the pages and catalogues related.

Articles or theses, as suggested by a writer in the Engineering Record, call for an extremely useful application of the card index. In preparing one of these papers the first step should be to jot down on temporary index cards facts of interest and data as collected in consulting references upon the subject. The references should always accompany the notes on the cards. If these notes are of sufficient value to be saved on their own account they should be made on permanent cards as for the index. For bulky data a note of reference only will be sufficient to enable the scheme of the article to be planned. These data as collected are assorted in the order of their sequence in the article to be written and will give at any time at a glance the general outline of the article and its progress. When all data have been collected and the notes arranged in their proper order, it is a very simple matter to write the article with the notes spread out in their proper order at one side. The majority of the notes can be enlarged upon for the article, probably without consulting the references, but by checking off each slip as used in the article time may be taken to consult references without causing confusion.

Correspondence, however extensive, becomes under perfect control when systematized by a card index.

Drawings are indexed on cards, though not in the Index Rerum, as indeed it is not advisable to do with catalogues above mentioned. The card of each drawing serves also for records related to the drawing. These and the following cards are usually of larger size, as 4x6. Obsolete drawings

will have their cards withdrawn from the working index. Patterns may be treated in the same way, with card record of dates when made and altered, cost of making, changing and repairing, where shipped and when returned, weight and material of part, etc. Stock accounting is facilitated by a card index, with records of purchases and sales, or receipts and distributions as of a general storehouse; the foreman is enabled to keep close and low stocks, and taking inventory is easier. This is found very successful in the great railway general storehouses where everything is found, from driving wheels to oil, from books to fry pans; porcelain, pins, pig iron, velvet, acids and gun powder. Employes' records are peculiarly suited by the card index, cards being so easily transferred from active list to left list, or then reinstated. Foremen are apt to keep these by memory only, and a new foreman would be without such a record. Mistakes in wages offered are prevented. Tools are sometimes not used because a workman says he can do a job in less time with an improper tool than would take to hunt up the correct tool. A systematized tool room uses the card index to excellent advantage, for no one can memorize all the special tools and their uses. The making of duplicate tools is also prevented. Factory costs use cards having accurate count of labor and material for each machine carded, where labor was spent, profit and loss being also entered upon the same card. Every maker of any saleable article, and almost any dealer, knows the value of a ready reference record of the cost of his article, or of the markets; costs of freight handling are as easily added, together with the various and fluctuating quotations that may come to his hands. Cost keeping must be so simple that it will be kept up readily; and doing away with clerical labor tend to this. Test department records are kept on cards to good advantage. Such records are expensive, hence should not be buried, but be readily accessible when sudden demand comes, as is so often the experience in that department of a railroad.

This subject might be extended into hours if once the field of mechanical engineering were left. The card index has been welcomed into every field where system and time are valuable. Half a dozen years ago it was unknown to the great body of business men. Today it is seen everywhere where progress is the rule. Devised for use as a library catalogue, it has been adopted by business men in all the leading branches of commerce. Transportation companies, insurance companies, banks, building and loan associations, schools, laundries, dentists, physicians, scientists, governments, real estate agents, societies, publishers, advertisers, churches—the list is not ended of those flocking to the new method.

The secretary of the American Society of Mechanical Engineers, himself an eminent engineer, writes: "I would say that in my opinion the card index is a branch of study which should be made part of every engineer's college course."

Briefly, the card index then has the following advantages:

Accessibility—always get-at-able—nothing is buried and lost.

Time-saving—for the searchers after information.

Expansibility—only one end, the beginning. Can enlarge forever and still be as good.

Order—new material inserted into the exactly proper place.

Adaptability—suits every frame of mind, and every sort of business; varied classification.

System—encourages system in vast accumulating data and brings it under general heads of classification.

Divisibility—some cards can be removed for temporary use elsewhere, or for permanent transfer.

Labor-saving—nothing has to be rewritten; saves clerical labor.

Simplicity—can be operated by the inexperienced.

Contractibility—no need of retaining useless, outgrown matter.

No wasting of spaces—it is impossible to apportion blank spaces in books so that they will fill evenly.

Always being up to date.

Rearrangement made easy.

Substitute for memory—supplementing it and becoming independent of existing hired memories.

Classifications within the index—by using tab cards.

In conclusion be it said that engineering periodicals, to the extent that they record or store in ink but do not disseminate information, are fulfilling only a small, a very small, portion of their possible usefulness. It is for each individual student, and even the greatest engineer is still a student, to declare which portion of the paper's usefulness he will accept at once and the day following. Can he afford—you—to neglect the opportunity of becoming acquainted with all the papers? Form a good habit, it will cling. Learn to doubt; you will afterwards believe better. Feed on the plaints of the nations rather than always in your own manger. Share your good things and unite forces; and some day a leader, know how best to lead. Engineering periodicals and the card index are not the fabled philosopher's stone, turning all metals into gold, but an unfading love for our profession can use them, among the other reagents, to bring out the measure of true worth within the capacity of each man.

LINE CONSTRUCTION FOR RAILWAY TRANSMISSIONS.

In reviewing the present-day practice in transmitting electricity for the operation of railways, The Street Railway Journal says that the pole lines do not usually receive special consideration because of the common practice of carrying the high-tension feeders on the same poles which support the trolley wire. The spacing and dimensions for the line are determined rather with reference to the trolley structure and heavy low-tension feeders than according to the requirements of the high-tension circuits. The occasional deviations from this rule of common use of the pole lines are mainly due to the necessity of dodging local difficulties in the way of crowded streets and large shade trees. The high-tension lines themselves present considerable variations in general arrangement. Perhaps the greatest variation from special transmission practice lies in the spacing of the lines. The ordinary railway transmission by reason of the common use of poles for several purposes allows less space between wires than is generally found desirable. All high-tension line work has suffered from too close adherence to the old precedents set by telegraph and telephone lines with their multiplicity of light wires. Of course, it is possible to operate with 10,000 volts to 15,000 volts even on the old 14-inch spacing, but as experience has been gained in high-voltage work, the spacing has gradually increased, for various reasons. So far as mere striking distance is concerned, moderate spacing is sufficient, even taking surging into consideration. It is found, however, that a widely spaced line is much safer from accidents than one laid out on less liberal principles. Twigs blown from trees would many times shut down a line with 18-inch spacing, where one with 36-inch spacing would escape, and the same principle holds for various other casual sources of short circuiting.

It is well, therefore, that railway practice is changing, as we have pointed out, in the direction of wider spacing. With respect to the location of the wires upon the poles, most roads adhere to the usual triangular construction. Some recent lines have put all the wires in the same horizontal plane, however, acting on the principle that the advantages of the other arrangements are largely theoretical. So far as railway transmission goes, the electrical difference be-

tween the two arrangements is probably negligible, and in so far the change in construction is quite justified. There is, however, a considerable practical gain in the triangular arrangement with the vertex up in immunity from short circuits. A flat rank of wires at the top of the pole affords altogether too good a chance for the lodgment of things that will produce short circuits. The same things would often fall through the triangular arrangement without holding an arc long enough to do any material damage. At the voltages commonly used in railway transmission the triangular spacing with not less than 3 feet between wires would seem to be generally advisable, and 4 feet is safer than 3 feet. As regards the pole material, it is worth noting that pins on these systems are exclusively wooden; in the later lines, extra long, and treated with insulating material. This is in general good practice, although very many lines are now built with steel pins, and for that matter, with steel poles. The railway transmission systems here considered use, however, exceptionally small conductors and rather moderate voltages. The mechanical and electrical strains are therefore rather small, and there is no need of insulators too massive to be readily supported on wooden pins, and no very great strain due to the weight of the lines themselves. There has been, therefore, no object in going to steel construction, since the wooden one is amply strong and possesses some advantages in the way of extra insulation. The voltage of most of the railway transmission lines here considered is hardly high enough to bring up the difficulty sometimes encountered by the disintegration of wooden pins, even were they not treated. Apparently there has been some little difficulty with burning, however, which may be expected, since few of the lines are specialized for high voltage beyond the insulators and pins.

The modest voltage of most railway transmissions is quite sufficient excuse for the lack of noticeable novelties in the transmisison work. Most of the voltages are under 20,000, and so easily taken care of with very little specialization. One hardly need expect any extraordinary difficulties below 40,000 volts or so, and hence unusual precautions are unnecessary. Even in the matter of lightning protection nothing out of the ordinary is recorded so far as the high-tension lines are concerned. Altogether, power transmission at 20,000 volts or so has become so much of a commonplace that it is rare to find novelties. The coming of a. c. railway motors will probably bring high-voltage work into greater prominence, and will doubtless produce plenty of engineering novelties. For the present, transmission lines vary most in the soundness of the mechanical design.

ADAPTING MACHINERY TO THE CAPACITY OF PACK ANIMALS.

One of the problems that sometimes confronts the machine designer is to make the construction so that no part shall exceed a weight of, say, two to three hundred pounds, or that which can be carried by a pack animal. This applies, of course, to mining machinery which has to be transported over mountains and into unsettled parts where roads have not been built. In some cases, however, it taxes the ingenuity to provide this, especially where the machinery is of such a nature that it must necessarily be integral. For example, the steel cables for hoisting have to be transported in full length as much as possible to avoid the defects of splicing. In such cases the matter is up to the manager of the pack train, but the method followed is very simple in scheme, although not always simple in the carrying out—if some of the animals are evil-disposed. It consists simply of uncoiling the cable and recoiling it at intervals to the required burro load, then leading to the next animal, where another coil is gathered, and so on until the whole cable is distributed among as many as are necessary to carry the total weight.

TRANSFORMATION OF ELECTRIC POWER INTO LIGHT.*

By Charles Proteus Steinmetz.

Of all the achievements of modern science or engineering the production of light is the least creditable. In the transformation of electric power into mechanical power, as in the electric motor, or the transformation of mechanical power into electric power, as in the dynamo, efficiencies far higher than 90 per cent. have been reached. The transformation is practically complete. All further advance must be expected in the direction of increased reliability of operation, decreased size and cost, etc. Even in the steam-engine or steam-turbine, 60 per cent. or more of the available energy of the steam as it issues from the boiler is recovered as mechanical work.

In the production of light, the efficiency of the incandescent lamp is measured by a fraction of one per cent., and if we should succeed in increasing the efficiency of light production tenfold—get ten times as much light as we get now from the same power—the efficiency of production of light would still be ridiculously low; and even with a hundred times its present efficiency, it probably would compare unfavorably with efficiencies that are familiar to us in other electrical apparatus. While the incandescent lamp is more efficient than the gas-flame, or the kerosene lamp; that is, gives less heat with the same light, still its efficiency is extremely low. The main reason for this condition appears to be that in the incandescent lamp or the ordinary carbon arc-lamp the light is really a by-product; that is, the lamp converts electric energy into heat, and only incidentally produces light.

Lighting by Incandescence.

If energy is impressed upon a solid or a liquid, as by passing an electric current through a carbon filament, and no other work done, the body is heated. This energy must be given off again; it is given off partly by conduction, but largely by being radiated from the incandescent body. By increasing the power, the amount of radiation increases; and there are changes in the quality of the radiation too: first appear radiations of very great wave-length or very low frequency, then, with the increasing power, higher frequencies appear; that is, the wave-length of radiation becomes shorter. In other words, in addition to the long waves which appear in the beginning, shorter and shorter waves appear: not only the total amount of radiation increases, but also the variety of waves increases and, ultimately at a certain amount of heat given to the body or at a certain temperature, waves as short as 750 u u appear. These are noticeable to the eye as dark-red light. Then still shorter waves appear gradually: orange, yellow, green, blue, lavender, violet. Beyond wave-lengths of 400 u u the waves again become invisible, as so-called ultraviolet waves.

Of the infinite variety of waves radiated by a heated body—from the long heat waves given by liquid air to the shortest ultraviolet waves, many octaves of wave-length in all—somewhat less than one octave is visible to the eye. These wave-lengths are useful as light; the rest is wasted energy. A parallel would be found in the case of a musical instrument of six or eight or more octaves, producing less than one audible octave. To this fact is due the very low efficiency of light production by heat: of the total system of radiation only a very narrow range is useful, less than one octave.

Of these useful rays, the visible three-quarters of an octave, none appears until the temperature is fairly high. Below that, only the long waves appear. That means the average wave-length of radiation decreases with the tempera-

*From a paper presented at the 211th meeting of the American Institute of Electrical Engineers, New York, November 23, 1906.

ture. Or, with increase of temperature, not only the existing waves become intense, but shorter and shorter waves appear, and the intensity maximum moves toward a shorter wavelength. With increase of temperature, the percentage of visible radiation thereby becomes greater and ultimately reaches a maximum, or the efficiency would be the highest when the maximum intensity lies just within the visible octave. Where this maximum may be is unknown, but it is beyond the temperature of the crater of the arc, possibly somewhere between 4,000 degrees and 5,000 degrees Cent. At that temperature the efficiency of the incandescent light is a maximum, and probably from one-quarter to one-half watt per candle power. But even then the efficiency is not high, 5 to 10 per cent., or thereabouts. It follows, however, that even if we could raise the incandescent body to the temperature of maximum efficiency, we would still get only about 5 to 10 per cent. of all the energy as light. The other 90 per cent. would be ultraviolet, chemical or actinic rays, X-rays, or long heat-waves. There is thus an absolute limit to efficiency of lighting by incandescence.

The higher the temperature the greater the light efficiency of an incandescent body. Carbon is apparently the most refractory of all substances—its boiling point being somewhere near 3,500 degrees Cent., so an incandescent body, at the highest possible temperature and the incandescent crater of the carbon arc are the most efficient sources of light by incandescence. They are still somewhat below the temperature of the efficiency maximum.

Incandescent lighting is effected by the electric current, either by raising the temperature of the light-giving solid body, a lamp filament, by passing a current through it, or by passing the current from it into another body. In the latter case the temperature of the boiling points of the material is reached and the crater of the carbon arc lamp is at the highest temperature which can be reached; gives it an incandescent light of maximum efficiency, probably not very far from half a watt per candlepower. But the large amount of energy, which is conducted away by air currents, etc., greatly reduces the actual efficiency of the carbon arc below this value.

When producing light by passing an electric current through the conductor, as in the incandescent lamp, no such efficiency can be reached. Here carbon is also chiefly used. The higher the temperature of the incandescent-lamp filament, the greater is the efficiency; but the limit of the temperature is not the boiling point of carbon, 3,500 degrees Cent., but far below that; it is the temperature where evaporation of the filament becomes so rapid as to limit its life below economical requirements. This is probably not very far from 1,800 degrees Cent. Far below the boiling point, evaporation takes place: water evaporates at ordinary temperatures; even below the freezing point snow and ice evaporate very noticeably. An incandescent carbon filament evaporates, thereby decreasing in cross-section, and increasing in resistance; the current decreases, therefore the temperature decreases and with the temperature the efficiency decreases. As the condensed carbon vapor blackens the globe and obstructs the light, another decrease of light results from absorption. Thus efficiency has to be sacrificed in the incandescent lamp to get good life, and the specific consumption of electric power, instead of being one watt per candlepower (as in the case of the arc lamp) becomes as high as four watts per candlepower.

The arc, then, is the more efficient illuminant. But its efficiency is still low, and here there has been a similar result; to increase the life, the efficiency has been decreased by enclosing the carbon arc, in the present long-burning lamp. Increasing the efficiency of the arc by reducing the conduction of heat by a decrease of the diameter of the carbon has also been tried, with the same result—exchanging efficiency for life.

In the incandescent lamp, the problem of increasing the efficiency can be attacked in two ways. One way is to replace the carbon by a material which has a lower vapor-tension at high temperature. While carbon has the highest boiling point, it is not the boiling point which is of importance in a lamp filament, provided that this point is sufficiently high—it is the vapor-tension far below this point.

For instance, the metals osmium, tantalum, wolfram (tungsten) have a lower melting point or boiling point than carbon, but they have at the same high temperature a lower vapor-tension, due possibly to the much greater atomic weight and so much greater heaviness per molecule (atomic weight of carbon, 12; osmium, 191; tantalum, 183; wolfram, 184). These metals can be operated at a higher temperature than carbon, and as lamp filaments they give a much greater efficiency than the carbon filament.

The efficiency of the incandescent lamp can be improved by replacing the carbon filament with a material which has a lower vapor-tension, and a sufficiently high melting point. Tantalum, osmium, wolfram, or tungsten as materials for incandescent-lamp filaments, promise to revolutionize the incandescent lamp, by holding out fair promise of an ultimate efficiency of about 2 watts per mean spherical candlepower for tantalum, 1.5 watts for osmium, and 1 watt per mean spherical candlepower for wolfram—compared with about 4 watts per mean spherical candlepower for the carbon-filament lamp. The objection to these metal filaments obviously is the low resistivity inherent to metals, which restricts their use to relatively larger units, or at least makes difficult the production of low candlepower sizes.

Another way of improving the efficiency of the incandescent lamp is by improving the carbon. The vapor-tension depends not only on the chemical constitution, but also on the physical structure. Ice evaporates very much slower than a mass of loose snow. Furthermore, it is possible to produce different forms, possibly allotropic modifications of carbon, of different rates of self-destruction. The product of carbonization of fibre or cellulose can not be run at as high a temperature with the same length of life, as can carbon deposited from hydrocarbons, as benzol or benzine, by high temperature. Experiments with carbon at very high temperatures show probably greater variations in the character of carbon, than with any other material. Possibly this is due to the tendency which the carbon atom has more than any other atom, of polymerization, and especially ring formation, which results in the formation of allotropic modifications of carbon, having the greater stability of such polymerized molecules. So at the boiling point of carbon, the carbon deposited from hydrocarbons converts, under the influence of atoms which can enter and leave the carbon chain, into an allotropic modification having pronounced metallic characteristics, as elasticity, a positive temperature coefficient of resistance, etc., and very great stability, so that as a lamp filament this form of carbon can be run up to a considerably higher efficiency, in the so-called "metallized filament."

THE ARC.

An entirely different set of phenomena is met in arc conduction. The electric arc makes its own conductor. That is, the current is carried across the gap between the electrodes by a vapor-bridge, produced by the current from the material of the negative electrode and maintained by the current as a high-velocity vapor-stream issuing from the negative towards the positive, and more or less surrounding the positive terminal. The spectrum of the arc, therefore, is that of the negative terminal, but independent of the gas or vapor filling the space around it, or of the material of the positive terminal, except indirectly by the effect of heat, etc.

The continuous production of the vapor-stream requires power in raising the negative material to the boiling point, evaporating it, and producing its rectilinear velocity. This

power must be supplied by the electric circuit, as a potential drop at the arc terminals, independent of the length of the arc and of the current—if the volume of the vapor-stream is assumed as proportional to the current, which seems to be the case. This potential drop, e_0, may be called the counter electromotive force of the arc.

The temperature of the arc-stream, at constant pressure in the surrounding space, must be constant, that of the boiling point of the material of the negative terminal. The power radiated per unit surface may therefore be also assumed as constant, and the total power radiated, and therefore the power consumed in the arc stream, as proportional to its surface; that is, to the product of length by diameter. Since the section of the arc-stream can be assumed as proportional to the current, it follows that the voltage consumed by the arc-stream is inversely proportional to the square root of the current, and approximately proportional to the arc-length, or, when allowing for the abstraction of energy from the arc-stream by the terminals, proportional to the arc-length plus a small constant quantity.

This gives the theoretical volt-ampere equation of the arc:

$$e_0 = 36 \text{ plus } \frac{130 \ 1 \text{ plus } 0.33)}{\sqrt{i}}$$

Giving the arc length l in inches, numerical values of this equation are:

Carbon Arc:

$$e_0 = 36 \text{ plus } \frac{130 \ (1 \text{ plus } 0 \ .33)}{\sqrt{i}}$$

Magnetite Arc:

$$e_0 = 30 \text{ plus } \frac{123 \ (1 \text{ plus } 0.05)}{\sqrt{i}}$$

With sinc or cadmium the counter electromotive force of the arc is:

$e_0 = 16$ volts: with mercury, $e_0 = 13$ volts.

Separating two carbon electrodes from each other and observing the voltage at the moment when the carbons leave immediate contact with each other and the voltage suddenly rises, or observing the voltage immediately before the carbons, when shortening the arc, come in contact and the voltage suddenly drops, gives values around 28 volts. This, in connection with the high value of the constant $c = 0.33''$ looks as if in the carbon arc the seat of the counter electromotive force e_0 is not the immediate surface of the terminals, but a part of e_0, about 8 volts, residing in the space surrounding the electrodes. This phenomenon may, however, be explained also by energy transfer from the hot crater of the positive terminal to the negative terminal at a short arc-length.

For very low currents, where the arc-stream gets very thin and unsteady, and abnormally high energy losses may be expected, the above equations give small values; that is, the observed arc-voltage is higher than the calculated, especially with long arcs. So for the magnetic arc of one ampere, we find:

At arc-length.....	⅛ in.	½ in.	1 in.
Observed voltage	58	108	184
Calculated voltage	51.5	97.5	159

These equations obviously apply to the arc at constant pressure, as an arc in air, in which the arc-section varies with the current. For an arc of constant section, in which, therefore, the pressure and the temperature varies with the current, as the mercury arc in a vacuum, by similar considerations an approximate volt-ampere characteristic is found. This is for the mercury arc:

$$e = 13 \text{ plus } \frac{1}{1.68d - 0.066i - \frac{1.3d^2}{1}}$$

with non-volatile positive terminal, and:

$$e = 13 \text{ plus } \frac{1}{1.68d - 0.114i - \frac{1.3d^2}{i}}$$

with mercury anode.

where: l = arc-length,

d = arc-diameter, in inches.

From the character of arc-conduction—that the current makes its own conductor—it follows that the arc must be started; that is, the vapor-bridge which carries the current must first be produced by the expenditure of energy before the current can flow. This can be done in many ways: by bringing the terminals in contact with each other and so starting the current, and then by withdrawing the terminals from each other to form the arc-stream by the current; or by jumping an electrostatic spark across the gap and so starting conduction.

It also follows that the arc is a direct-current phenomenon, and in general can not exist with an alternating current. With an alternating electromotive force at the end of the half-wave, the current dies out and, therefore, also the vapor-stream; and the next half-wave, to pass in opposite direction, requires a vapor-stream moving in the opposite direction. This does not exist, and the current does not pass; but the arc dies out at the end of the half-wave, except if the supply voltage is sufficiently high to jump a spark across the terminals at every half-wave, through the residual vapor left by the preceding half-wave. An alternating arc, therefore, must be at every half-wave in the condition for starting by a spark. Stroboscopic photographs with metal arcs show this phenomenon; a sharply defined static spark at every half wave, gradually spreading out to the more diffuse arc-flame and then dying out at the end of the half-wave, to start again by a spark at the next half-wave.

The voltage required to maintain the vapor-stream; that is, the voltage consumed by a direct-current arc, as discussed above, increases with increase of the arc-temperature; that is, increase of the boiling point of the terminal material. It is lowest for the mercury arc, highest for the carbon arc.

Vapors, like mercury, zinc, etc., are very good conductors when in motion under the influence of the current, of a conductivity comparable with that of electrolytes; when not under the influence of the current they are almost perfect insulators, and so can be distinguished from the so-called "conducting gases," as hydrogen, air, etc., as "non-conducting vapors." Low-temperature metal vapors thus are non-conductors.

The Arc as an Illuminant.

The spectrum of the arc is that of the negative material; its temperature that of the boiling point of the negative. There are, however, some apparent exceptions. For instance, the arc-stream can be superheated by using a high-frequency oscillating current of sufficiently high voltage to maintain an alternating arc, and frequency so high that a sufficient vapor-stream cannot be formed during the half-wave. In this case, groups of spectrum lines frequently become prominent, which are insignificant with saturated vapor: the mercury arc becomes bright-red in color; the iron arc loses most of its brilliancy, but gives a great quantity of intense ultraviolet rays, etc. Likewise, the spectrum of the positive, or a constituent of the positive terminal can be made to appear in the arc.

The tip of the positive is heated to the temperature of the vapor-stream, in the carbon arc the temperature of boiling carbon. If the positive terminal consists of, or contains some material which boils below the temperature of the vapor-stream, then it will evaporate out of the positive, and may thus enter the arc-stream. For instance, in a carbon arc, or arc with carbon as negative, if a carbon is used as positive, impregnated with calcium fluoride or borate, which has a relatively low boiling point, then the calcium vapor enters

the arc-stream and is thereby heated to the temperature of the carbon arc. It becomes luminescent, whether directly by heat, or indirectly by chemical dissociation, or otherwise, need not be considered here. So the efficiency of a carbon arc can be increased by feeding into the arc-flame the vapor of some material which gives a brilliant spectrum—as calcium, which gives a yellow light of very great brilliancy. It is fed into the arc by the positive terminal, because this is the hottest, and the efficiency depends entirely on the temperature of the positive. If the positive is very large, so as to keep cool and consumes slowly, the efficiency decreases, because it is produced only indirectly by material being evaporated from the positive and then as vapor entering the arc-stream. Therefore a high temperature and rapid consumption of the positive are necessary.

It is entirely different with the true luminous arc, which carries the light-giving material into the arc-flame by the electric current, as the vapor-blast, which carries the current. The carbon as negative material is objectionable, since it gives the non-luminous carbon arc. Iron appears to be a very suitable material, since it gives a spectrum extending over the whole visible range. It produces practically a white light. The positive can then be maintained cold without affecting the brilliancy or efficiency of the arc. The negative can also be cooled without appreciable effect on the efficiency, since the current still produces the vapor-blast from it, and so the light. If cooled too much the voltage in the arc may rise a little, because it requires more energy to produce the iron vapor from the cool negative than from the hot negative, but still the efficiency is not much affected.

There are, then, two distinct ways of producing luminescence of the arc; first, directly by using some material as negative which gives a luminous spectrum; that is, a spectrum with many lines in the visible range, preferably covering this whole range, to get white light; secondly, indirectly by using some material to carry the current which gives a very high temperature to the arc-stream—which means practically carbon—and making the arc-stream luminous by feeding some light-giving substance into the arc from the positive terminal. In the former case the arc has the characteristic of the iron arc or titanium arc, whatever material is used; in the latter case, it has the characteristic of the carbon arc.

Since the carbon arc is the steadiest arc, the most work has been done in the latter direction. The former method, of feeding the luminescent material by the current from the negative material, has the advantage, however, that the efficiency does not depend on the temperature of the electrodes: the rate of consumption of the negative electrode can thus be greatly decreased by maintaining it at low temperature; while the positive electrode, which takes no part in the arc conduction, can be made entirely non-consuming. This method seems to be a more direct conversion of electric power into light.

These two forms of arc have come into prominence recently; the flame carbon arc and the metal compound arc; that is, an arc in which carbon is not used, but some other material which gives a luminous spectrum, as iron or titanium. In the former case the characteristics are those of the carbon arc. All the materials which can be used to increase the efficiency of the carbon arc-calcium compounds are used almost exclusively—deposit as solids after passing through the arc-flame, and therefore ventilation must be provided to carry off the smoke; that is, the arc must be a so-called "open" or "burning" arc. The life of the electrodes is about 10 hours. Flame carbon arcs therefore have short-life electrodes, though their efficiency is high. Again, efficiency has to be balanced against life, or decreased cost of power against increased cost of electrodes and attendance. Here in the States the short-burning arcs for street lighting have practically disappeared. Indoors the excessive brilliancy and the smoke are objectionable, so that the flame carbon arc does not offer much prospect for general illumination.

More prospect of success appears to exist in the true luminous arc, an arc using as negative a material giving an efficient and brilliant spectrum. Such material should give lines uniformly distributed not only in the green or yellow, but over the whole visible range, and the material should not be attacked in air, even at high temperature. The arc must be an open arc, since the material deposits as solid, and to get electrodes with long life, a material is required which is stable at high temperature in the air.

There are very many metals which give luminous spectra, but those which give white are substantially the metals of the iron group only—iron, titanium, wolfram, etc.

Long-burning quality requires a material which is not affected, or only little affected by the air. This, in general, excludes the metals, but requires a stable oxide or other fairly stable compound, as some carbides are. It should also be a conductor, since as arc electrode it has to carry the current. In the intermediate oxide of iron magnetite (Fe_3O_4), a material is found which is a good conductor, is stable at high temperature as well as at low temperatures and gives a white spectrum. In such an electro luminescent arc, any stable material is suitable as a positive terminal. Copper is generally used because it is cheap, is stable at fairly high temperature, is a very good conductor of heat, and when heated by the arc carries the heat away with sufficient rapidity not to melt or oxidize appreciably. In all these arcs the vapor stream from the negative is a necessity. In the mercury arc it is easiest of observation, because the arc is inclosed in a glass tube.

The amount of vapor produced by the current from the negative is usually many times greater than necessary to carry the current, and most of it can be condensed without any appreciable change in the arc-stream. So also magnetite consumes at a much greater rate than is necessary, of an order of ¼ gram per-ampere-hour. This rate of evaporation is greatly reduced by the addition of small quantities of a material which is chemically not much different from magnetite, but is much more refractory; so that at the temperature where the magnetite melts this material is still solid and forms a kind of sponge in which the melted magnetite is held and its consumption greatly retarded.

Magnetite, however, while a good conductor of the arc-stream, is not very efficient as a producer of light, and added thereto are other materials which give a very high efficiency, as titanium compounds.

In the magnetite arc—as used at present, that is, in which the magnetite elctrode contains titanium oxide, etc.—magnetite is essentially the carrier of the arc conduction, just as carbon in the yellow-flame arc; titanium with its highly efficient white spectrum takes in the magnetite arc the same place as calcium in the flame arc, as light-giving substance, but titanium is carried into the arc stream by the current from the negative, while calcium in the flame arc enters by evaporation from the positive.

The elimination of carbon in the magnetite arc excludes combustion, and this increases the life of electodes to about twenty times that of carbon electrodes under the same conditions; but just as with the carbon arc, the efficiency of the magnetite arc can be varied over a wide range, with a corresponding variation of life in opposite direction. That is, by sacrificing some efficiency the life can be greatly increased, or the efficiency can be increased by somewhat reducing the life, by increasing the percentage of light-giving material; usually titanium oxide in the magnetite arc, calcium fluoride or borate in the flame carbon arc. In either case, a very high percentage of the light-giving material tends to the formation of a non-conducting slag at the electrode surface, and if the highest possible efficiencies are desired—¼ watt per candle-power, and better—the effect of the non-conducting, or poorly-conducting electrode surface has to be eliminated, by starting the arc from the side of the electrode, or some other method.

The titanium arc with alternating current cannot use magnetite as carrier, and titanium oxide as light-giving material; but titanium carbide is used as arc conductor. It obviously is not so incombustible as the oxide, but still so much more stable than carbon as to be well within the range of long-burning arcs.

To conclude, then, in the luminous arc we seem to have the first instance of a commercial application of a direct conversion of electric power into light, without heat as intermediary form of energy. It is not limited to very low values of efficiency. But so far it seems that only the green mercury spectrum, the yellow calcium spectrum, and the white titanium spectrum offer an efficiency so vastly superior to that of incandescent solids, that as regards the efficiency of light production no possible improvement in incandescent lighting could hope to approach it. Typical of these three most efficient spectra are the mercury-arc lamp, of practically infinite life and bluish-green color of light; the yellow-flame carbon arc of the short life of the open arc-lamp of old; and the white titanium carbide or magnetite arc, of a life equal to or greater than that of the enclosed carbon arc.

HIGH-EFFICIENCY LAMPS IN ELECTRIC RAILWAY SERVICE.

Some interesting figures bearing on the economy of high-efficiency lamps are contained in the following paragraphs, which are reprinted from the November number of the "Electric Railway Review":

Within the last two years incandescent lamp design has undergone such remarkable improvement in respect to the production of more efficient lighting units that every progressive central station man is thoroughly interested in the situation, and in many cities the familiar carbon filament lamp of 3.5 and 3.1 watts per candle efficiency is in no small danger of being superseded. It is not surprising, therefore, that electric railway men should be inquiring into the merits of these improved lamps, with special reference to their operating economy.

There is not the least doubt that the modern high-efficiency lamp—which has now been commercially produced in the 20-candlepower, 50-watt size, with a useful life of 500 hours—is capable of giving a much greater volume of illumination for a given expenditure of energy than the old standard carbon filaments. In fact, the results show a gain in efficiency (for the same life) of 20 per cent., and a gain in life (for the same efficiency) of 350 per cent. Comparing standard 50-watt lamps of 2.5 and 3.1 or 3.5 watts per candle efficiency, it is at once evident that while the consumer's bill for service may remain constant, he receives much more light for the same money when using the higher efficiency lamps at usual lighting rates, say from seven cents per kilowatt-hour upward. What does this mean for the electric railway?

Any fair consideration of the cost of lighting service must include the cost of renewals as well as depend upon the cost of power delivered at the lamp terminals. The first cost of a 50-watt, 20-candlepower lamp may be taken at about 20 cents against 16 cents for a 54-watt or a 50-watt 16-candlepower "old style" carbon filament lamp. The current cost of 1,000 candlepower-hours of light with electricity at 3 cents per kilowatt-hour is 12 cents for a 4-watt-per-candle lamp, 10.5 cents for a 3.5 watt lamp, 9.3 cents for a 3.1-watt lamp, and 7.5 cents for a 2.5-watt lamp. Pro-rating the renewal cost on the percentage of the expired life to the useful life we find that the total cost of 1,000 candle-hours is 12.5 cents for the 4-watt, 11.5 cents for the 3.5-watt, 11 cents for 3.1-watt and 9.5 cents for the 2.5-watt lamp, the useful life of each being 2,100 hours, 1,000 hours, 500 and 500 hours, respectively. Considering the actual cost of this illumination, with three-cent power, there is no question about the economy of substituting higher-efficiency lamps for those of lower economy. On many street railways long life is considered a point of greater value in a lamp than high efficiency, and for this reason 4-watt-per-candle lamps are much in favor. But with three-cent power even the labor-of-replacement cost cannot undermine the greater economy of the 2.5-watt unit for a given amount of illumination, and the improvement in car lighting which is possible with a 20-candlepower unit is very well worth considering in its effect upon the passsengers' comfort. On the other hand, where the lighting is to be effected by 8 or 10-candlepower units, the high-efficiency lamp capable of meeting the requirements is not on the market as yet, if indeed it will be in the near future.

The cost of power on many of the larger street railway systems is much nearer one cent per kilowatt-hour at the lamp terminals than it is three cents. Under these circumstances the power cost of 1,000 candle-hours of light is 4 cents for the 4-watt lamp, 3.5 cents for the 3.5-watt, 3.1 cents for the 3.1-watt and 2.5 cents for the 2.5-watt lamp. Estimating the renewals as before, we find that the total cost of 1,000 candle-hours is 4.5 cents for either the 4, 3.5 or 2.5-watt lamps, and 5.1 cents for the 4-watt unit. It is important to bear in mind the fact that renewal costs may be figured on several different bases, with room for slightly varying conclusions. This method, as stated, however, clearly indicates that the high-efficiency lamp of 50 watts consumption holds its own, even at the low rate of one cent per kilowatt-hour, but that it becomes more and more valuable as the cost of power rises. In car houses and shops there is no question that the superior distribution of light found in the new complete units—with the proper kind of reflectors—renders the metallized filament superior to the old-time carbon filament of lower efficiency. First-class light distribution in ample quantity has a value in stimulating shop production which can scarcely be estimated with exactness. As for the car service, exhaustive life tests under the conditions of service on different divisions with varying voltages and mechanical shocks, should be made before a final decision is reached as to the adoption of high-efficiency lamps.

WIRING CONDITIONS IN PUEBLO.

The "Western Electrician" notes that at Pueblo, Colo., an ordinance providing for the appointment of an electrical inspector has been recently adopted and is being rigidly enforced. The present standard for wiring is very good, and the few suggestions for improvements made by the Underwriters' Electrical Bureau inspector were well received. Some of the old wiring has come in for attention, and the overhauling of other equipments is under consideration. Considerable underground work is being installed, and when completed the pole lines will be removed from the more prominent business streets. The remodeling of the fire-alarm system has been stopped in the midst of the work, leaving the wires resting on the cross-arms instead of being fastened to the insulators. A heavy fall of moisture might interfere with the sending of signals from the more distant boxes. Stationary motors for elevators are being operated from the grounded trolley system.

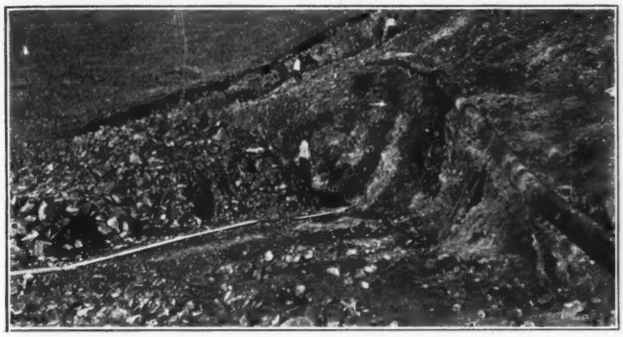
COAL TROUBLES IN FRANCE.

"Le Gaz" recommends the French gasworks, and especially the smaller ones, to combine in order to purchase coal in large quantities and thus to frustrate the devices of the coal syndicates, which are treating the gas companies unfairly through manipulating the prices of coal and withholding supplies on various pretexts, such as the scarcity of wagons. These tactics put the gas companies to such extremities that they have to submit to any terms. The matter is rendered worse through the special rates which the syndicates have obtained on the Government railways. "Le Gaz" says that the whole of the French industries suffer in the same way at the hands of the mining syndicates.

SECURING ROCK BY HYDRAULIC METHODS.

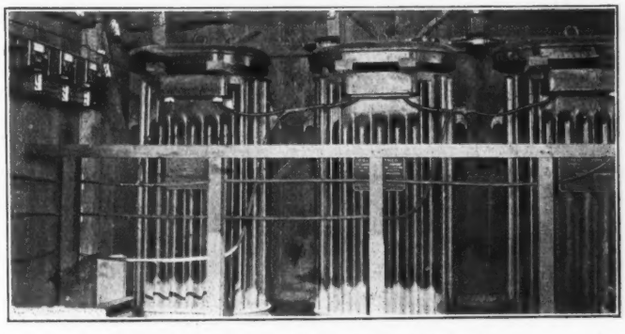
An interesting application of the principle of hydraulic mining to uncovering rock for building purposes is exemplified in the plant of the San Pablo Quarry Company, which is situated on one of the hills north of Point Richmond, overlooking San Francisco Bay. Beneath a covering of loose earth or clay varying in depth from 18 inches to 5 or 6 feet, and extending over 200 or 300 acres of the adjacent hillsides, there is available an excellent quality of rock suitable for street paving and macadamizing and for general construction in concrete.

To remove this upper layer of earth a hydraulic equipment has been installed, consisting of a three-stage centrifugal pump and a "giant" nozzle, such as is used in hydraulic mining. The piping is of riveted steel and is 10 inches in diameter. The pump is direct connected to two three-phase, 50-horsepower induction motors, and lifts water from the bay through a height of from 100 to 200 feet.



SHOWING ROCK AFTER SURFACE EARTH HAS BEEN WASHED AWAY.

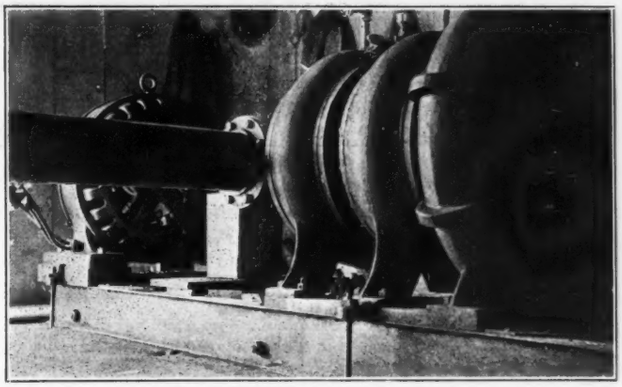
The loose earth requires no preliminary preparation before being washed away, but the clayey surface must first be loosened and broken up by blasting. From approximate calculations, the average capacity of this plant is about 30 cubic yards per hour. The average cost per cubic yard is between 8 and 10 cents. The pump is operated twenty out of twenty-four hours; the low tide interferes with continuous operation.



INTERIOR OF TRANSFORMER HOUSE.

Power for the motors is taken from a branch line of the Pacific Gas and Electric Company, which runs close by, just above the Point Richmond refineries of the Standard Oil Company. Three 75 kilowatt transformers, star connected on the primary side and delta connected on the secondary, step down the line pressure of 10,000 volts to the pressure of 500 volts required by the motors.

On account of the hydraulic mining laws prohibiting the washing of waste earth into the bay, it has been necessary to construct a long wooden bulkhead to catch this material as it comes down the hills. This bulkhead it built well out into the water and incloses an area of about 150,000 square feet.



THREE-STAGE PUMP DIRECT-CONNECTED TO MOTORS.

Steps have already been taken by the same company to install a large crusher, to be operated by Bullock three-phase motors. The piling for a pier, which will provide loading facilities for barges, has been constructed, and a tunnel run from the pier to connect with a shaft sunk from some convenient elevation. The crushed rock will be transported from crusher to barges by means of two belt conveyors, one of which will deliver the rock from the crusher to the mouth of the shaft, and the other will take it from the bottom of the shaft and convey it directly through the tunnel to the barges.

Work at this plant is progressing satisfactorily, and it is believed that the methods adopted will effect a considerable saving in the cost of supplying the crushed product to San Francisco and neighboring towns and cities.

FUEL CONSUMPTION OF STEAM AND ELECTRIC RAILROADS.

"Data contained in the annual reports of a number of the larger steam railroads," says the Electric Railway Review, "indicate that the annual coal consumption is on the average about 2,500 tons for each steam locomotive, and the cost of fuel is about 15 per cent. of the total operating expenses of the road."

From the United States census report on "Street and Electric Railways," covering 799 operating companies, the cost of fuel for power for electric railways appears to be about $15,000,000, which is a little over 10.5 per cent. of the total operating expenses. This figure is higher than would be obtained were only companies having the more modern generating plants included; in the census report is given a table based on the accounts of 17 selected companies in large cities which shows the average cost of fuel to be 7.2 per cent. of the total operating expenses. In view of recent improvements in power plant design strictly modern power houses might be expected to show an even smaller cost for fuel. In attempts which have been made to compare the fuel consumption of steam locomotives, with a view to getting data on the savings railroads might expect from the adoption of electricity for a motive power, the difficulty has been to find a suitable unit of comparison that would represent exact conditions. The fuel economy of locomotives is at a great disadvantage when their average performance is measured by the useful work performed and compared with stationary engines and boilers. When the locomotive is at work and well under way hauling a train, the consumption of coal per horsepower-hour is low, but it is found that of the time locomotives are under steam and in the hands of the transportation department they are not making mileage more than 50 per cent. of the time, and based on the total time there is an average of only about five miles per hour for freight service where schedules of 15 to 20 miles per hour are the rule. All the time the locomotive is standing at terminals or on sidetracks awaiting orders, it is during six months of the year exposed to the cold winds and the losses of heat through radiation are considerable.

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EDITORIAL.

The Forest Reserves and Electric Transmission

There was rejoicing in the West and particularly among those interested in water power electric transmission, when the national government a few years ago, came into control of large tracts of forest-covered land in the mountains, with the object of preserving these forests and, among other things, conserving the water of the mountain streams. At the present time, however, there is pending before the Department of Agriculture in Washington a matter of grave importance to the entire West, and especially to the Pacific Coast.

It is proposed to make a charge against all water-power electric companies that find it necessary to utilize any portion of the forest reserves, and many protests have been presented on behalf of a number of the electric power companies of California against such action being taken. The proposed charge is one which the West will have to bear exclusively, and does not apply to the East at all, since there are no large or important forest reserves in that portion of the United States.

It is proposed to charge all power companies operating in the forest reserves, either by the metered electrical energy at the rate of twenty cents per 1,000 kilowatt hours, or by an annual fixed charge of seventy-five cents per theoretical horsepower in the water used. Based on the prevailing rate for electric power in California, the effect of either method of charge would be that the government, under the direction of the Department of Agriculture, will demand from the electric power companies from one to three per cent. of their gross income. On the rates charged by the power companies at Niagara, the payments which would be made to the government amount to about six per cent. of the total receipts from the sale of electric power. Such a charge is out of all proportion to the benefits enjoyed by the power companies at the hands of the government, and is certainly most unjust. Besides the proposed charge, either upon the basis of the metered electrical energy or theoretical horsepower, takes into account not only the quantity of water used but the head available. The establishment of a Forest Reserve certainly does not modify the topography of the locality so that in this respect the basis of charge proposed by the Department of Agriculture involves an absurdity.

It is doubtful if such a proposition would have been made if the control of such matters were in the hands of men who thoroughly understand the situation in the West. If the electric power companies use the forest reserves, thereby causing any expense to the government or interfere or oppose the efforts of the government to maintain the forests, it would undoubtedly be proper to make the power companies recompense the government in a proper and equitable manner. But as a matter of fact the water-power electric transmission companies have done more than the government to preserve the forests and conserve the water of the mountain streams.

In many of the power plants the flood water is stored in reservoirs and is returned to the stream during the season of minimum flow. This is precisely what the preservation of the forests is supposed to do. The flood water which was formerly wasted entirely and allowed to flow to the Ocean is, as a result of the construction of such high-mountain reservoirs by the power companies, used for irrigation in the valleys after being utilized for the generation of power.

In the construction of every water-power electric system, roads are built and trails constructed through the mountains which are continuously used by the forestry officials. Such roads and trails are very effective fire breaks. Also in building a transmission line through the forest reserve, all the trees and brush are cleared away to a distance of about fifty feet on each side of the pole line, and these clearings have been found to be most valuable as fire breaks during serious forest fires.

In many cases but a very small part of the ditches, flumes and transmission lines are in the forest reserves. It would be manifestly unfair under these conditions to charge such a plant at the same rate as other companies whose entire system lies within the forest reserves.

The most unjust feature of the proposed charge is that it is based upon the gross receipts. A large part of the total cost of any plant is connected with the distribution lines and equipment for which the forestry department grants no rights whatsoever and for which it furnishes nothing.

Protests have been sent to Washington by the leading citizens of California, including the officers of commercial bodies, associations and financial institutions. It is a matter of the greatest importance to California as the extraordinary development in the transmission of power has caused wonderful advances in the manufacturing industries of the Coast. Also in the delivery of electric power to the valleys, the benefit to agriculture has been fully as great as a result of electric transmission as to other industries. The entire Sierra Nevada Range has many facilities for the storage of water, and when the available water supply of the Sierras is properly conserved, all the land in the great Sacramento and San Joaquin valleys may be brought to the highest state of cultivation, and the most effective way to accomplish this result is to encourage rather than discourage the construction of large water-power electric transmission systems.

It is of importance to note that no charge is to be made for the rights of way for railroads, or the necessary construction in connection with the development of mines, notwithstanding the fact that such railroads may and often do prove much more profitable than any electric power system. It is also true that probably no railway company or mining corporation has ever done a fraction of the work which has been done by the power companies to assist in the work of the Department of Forestry.

It is indeed most unfortunate that a bureau in Washington can take such an action which is so detrimental to the interests of the entire West. It is not proposed to charge for the water itself, which, of course, is directly under the control of the State, but it is proposed to use the water as a measure of the charge to be made against the power companies.

It is to be hoped that the proposed action of the Department of Agriculture will be most effectively defeated, by the protests of those interested in the commercial development of the Pacific Coast.

TRADE CATALOGUES.

The Westinghouse Machine Company, of East Pittsburg, Pa., has just made a very meritorious and instructive addition to advertising literature by the publication of a 66-page pamphlet on Gas Power. Those who are not familiar with the theory and construction of gas engines will find here much information of general and practical interest. There is a historical sketch of the development of gas-power systems, a discussion of gas energy and the Beau de Rochas cycle, a description of the various features of the Westinghouse gas engine, a discussion of gas engine testing, fuel gases and producer gas, and an analysis of some gas-power installations. The pamphlet is beautifully illustrated throughout.

The Westinghouse Machine Company has reprinted, in pamphlet form, the decription of the new central station of the Baltimore Electric Power Co., which appeared in the "Engineering Record" in June, 1906. The generators at this station are driven by steam turbines, and have an aggregate capacity of 8,000 kilowatts. There are many reproductions of photographs and drawings to show the constructive features of this plant.

COPPER CASTINGS.

Pure copper cannot be cast in sand without considerable difficulty; in fact, some deoxidizer is always used. For common copper castings from 2 to 5 per cent. zinc is generally added to get sound castings; but for electrical work this is useless. The only way to get good electrical castings is to melt pure electrolytic copper in a plumbago crucible under a thick layer of charcoal. When thoroughly melted 2 per cent. of silicon copper is added . The mixture is stirred with a stick and cast as soon as ready. Practical experience alone will show the correct temperature for casting copper in sand molds, and the proper temperature of the sand. It must not be cast boiling, but a fairly high temperature is necessary.—"Metal Industry."

STRAY CURRENTS.

The Electrolysis Committee of the German Gas Association is spending considerable time investigating many recent cases of injury to pipes due to the electrolytic action of stray currents from the rails of electric lines. Most of these cases occurred at Strassburg, Dresden, Hamburg, Erfurt, Stuttgart, Leipzig, Liegnitz and Danzig. The Association of German Street Railway Managers and the Association of German Electrotechnicians have expressed a willingness to study this subject in conjunction with the Gas Association Committee.

INTERNATIONAL COMPETITION.

Under the auspices of the Association des Industriels de France an international competition is to be held on April 1, 1907, to encourage improvement in accumulator design and construction. According to an announcement in the "Centralblatt fur Accumulatoren," awards will be made for the best primary element and accumulator submitted. In testing the entries for order of merit special attention will be given to the maximum output for a given weight and the smallest dimensions; also safety in erecting and maintaining, ease of transport, installation, and inspection. Each accumulator, which must not weigh more than 44 pounds, will also be tested in regard to the life of its plates and electrolyte. Full details of the type which it is intended to enter must reach the offices of the association (3, rue de Lutece, Paris) before December 31, 1906. The sum of 8,000 fr. (about $1490) is available for prizes. Further particulars may be obtained from the association.—"The (London) Electrical Engineer."

TELEPHONY IN ITALY.

United States Consul Paul Nash, of Venice, reports that the telephone service in Italy, both urban and intercommunal, has hitherto been almost entirely in the hands of two great companies—the Societa Alta Italia, operating in Milan, Genoa and Turin, and the Societa Generale Italiana pei Telefoni ed Applicazioni Elettriche, controlling Bologna, Florence, Rome, Naples and the Sicilian towns. The "Electrical World" notes that at the beginning of 1904 the ministry of posts and telegraphs took over the Venice telephone system, extending the service, raising the pay of the employes, and reducing the rates, but, in spite of increased expenses, putting aside some $12,000 a year toward a fund for the changing of the entire system. The time has now come when bids for this change are being made, and already three have been received—one from an American, one from a French and one from a German firm. These bids are yet to be submitted to the ministry at Rome by the local director. The ministry of posts and telegraphs appointed recently a commission to investigate the telephone service throughout the country, with the result that in many places a complete change was found to be necessary. In Rome, for example, the service was found to be extremely bad, and that town will probably be one of the first to be modernized in this respect. The appointment of this commission was the first step in the project of the ministry to take over control of the telephone service of the whole country. Milan has the central battery system, which is, as usual, working most satisfactorily.

INDUSTRIAL

A NEW PENDANT QUICK-BREAK SWITCH.

The Sarco Company, 906 Sixth avenue, New York City, manufacturers of standard wiring specialties, are meeting with big success among the electric lighting stations and the trade generally with their new pendant quick-break switch, as shown in the accompanying cut.

The switch is especially adapted for controlling ceiling lights, clusters and arc lamps, and while it is rated for six amperes and 125 volts, it has, in actual test, carried, without any noticeable heating, twice the amount of current and twice the voltage.

These switches are made in a number of different finishes to harmonize with its surroundings. The switch proper is mounted in a solid piece of porcelain and consists of two levers working on a rocker, causing, by means of two spring triggers and a double V cam, the necessary reciprocating movement.

The up-and-down movement of the two levers is guided by the construction of the porcelain holder so that the action is that of a quick-break switch, there being, however, no action of the switch jaws until a quick and clean make-and-break is desired, which is accomplished so rapidly and so positively and the contact surfaces being so ample that no arcing or heating is effected.

The careful workmanship and material used in these switches have made them practically indestructible.

The push buttons for operating the switch are marked for "on" and "off," one button being inlaid with pearl and the other concaved and ridged.

These switches are fitted with double bushings, the larger bushing being screwed into the top of the metal cap, and the smaller bushing threaded within the larger, so that, where it is desired to use reinforced instead of standard pendant cord, the smaller bushing may be removed and the pendant is still properly bushed by the larger one.

This new switch is now being carried in quantities in the stockrooms of central stations for the convenience of their customers.

AN ESSENTIAL ELEMENT IN ELECTRIC TRACTION SERVICE.

The air-brake has, for many reasons, come to be regarded as an essential part of the equipment of modern high-speed electric cars, either single or in trains. The more important of these considerations are safety, saving in time, and economy of operation.

Improved Facilities for Operation—Saving of Time.

Improved facilities for handling trains more speedily was one of the strongest factors in inducing steam roads to adopt air-brakes. Electric cars and trains are now being operated on much faster schedules and closer headway than heretofore, and the importance of any appliance which increases the net efficiency of rolling stock is self-evident.

Economy of Operation.

Statistics covering the past few years have shown conclusively that a material reduction in the quantity of power taken from the line is brought about by the use of air-brake apparatus. The average difference in the cost of operating an electric car furnished with hand brakes and one equipped with air-brakes, on roads running through large cities where frequent stops are necessary, has been proven by actual tests with Christensen brakes to be between 10 and 15 per cent. These figures are based upon current consumption.

The saving in current by the use of the air-brake is due to the fact that the powerful and instantaneous action of the brake renders it possible to leave the brake-shoe clear of the wheel, even when newly adjusted, and allows the motorman to run in "full release," except when he has occasion to stop or check the car; whereas, with the hand-brake the shoes must not only be adjusted tight, but within city limits the motorman must keep the brake dragging, in order that he may stop quickly enough to avoid collisions. It is evident from the above that, in addition to the economy of power, there is also a large saving in brake shoes and labor incidental to their adjustment.

Motor Compressor.

Compressors furnishing air for operating the brakes are driven by electric motors (stopped and started without resistance of any kind) of the series type, the coils of which are form wound and thoroughly insulated. They are carefully built, both mechanically and electrically, and so constructed that the armature and fields can be removed, if necessary, without disturbing any other parts of the machine. Each motor is thoroughly tested before leaving the shop. It is mounted directly above the compressor.

There are two cylinders for the compressor, each of which is fitted with a single-acting piston of the most approved construction. A steel crank shaft, with cranks set at such an angle as to give the best balance to the moving parts, operates the connecting rods.

The top of the compressor is formed by the base of the motor, and the gear (of the Herringbone type), which is keyed on the crank shaft, is enclosed in a cast iron casing. The noise of the gear and pinion is almost entirely eliminated, for the reason that the teeth are cut to mesh with an accuracy which insures smooth and quiet running. The working parts of the compressor are enclosed. Thorough lubrication of all the moving parts is effected from an oil reservoir in the base, supplied through an oil-filling elbow. The latter also gauges the proper height of the oil in the casing. The reservoir communicates with the gear case, carrying oil up to the pinion on the armature shaft.

In the cylinder head the suction and discharge valves, of material and construction particularly adapted to the service required, work independently of each other. No springs are used in connection with these valves, which are seated by gravity and can be changed about, at need, providing the seats have worn equally. The cylinder head, valves, pinion or gear may be removed at any time, without disturbing the other parts.

Main Reservoir.

The air, as fast as compressed, passes into a suitable reservoir (of seamless cold-drawn steel), where its volume is kept within proper limits by means of an automatic governor regulating the supply.

Automatic Governor.

The governor, which starts and stops the compressor, consists of an ordinary pressure gauge mechanism with a special hand. Its operation is very simple, as follows: When the hand comes in contact with a small stud at the position of minimum pressure, it allows the current to flow through a magnet coil. A plunger to which the contact pieces for the motor circuit are attached is operated by the magnet coil, thus closing the circuit and starting the motor. When the pressure reaches the desired maximum, the hand strikes another small stud, thereby causing the current to pass through a second magnet. As soon as this magnet is electrified the plunger is impelled in the opposite direction and opens the motor circuit.

The Engineer's Brake Valve.

The engineer's brake valve, by means of which compressed air is admitted from the main reservoir to the brake cylinder and thence discharged into the atmosphere, has been very carefully designed so as to enable the motorman to manipulate it in a manner to secure the best possible results with the least consumption of air, also to make his stops without shock or jar.

Air Gauge.

An air gauge is mounted near the engineer's valve in such a position as to be easily observed by the motorman.

Brake Cylinders.

When the brakes need to be operated, air from the main reservoir is admitted, through the engineer's valve, to the brake cylinder, which applies pressure to the shoes and thence to the wheels by means of suitable leverage mechanism.

The brake cylinder is provided with a loose piston rod so arranged that when the hand-brakes, and not the air-brakes, are used the loose piston rod only is moved. The pipe in which it slides is fixed to the piston of the brake cylinder, which is held in release position by a spring.

Piping.

The necessary piping consists of two sections, viz.: the reservoir pipe, connecting the main reservoir with the engineer's valve, and the train pipe leading from that valve, which runs the entire length of the car or train, hose couplings being used between cars. A stop cock at each end prevents the escape of air, when the opening is exposed.

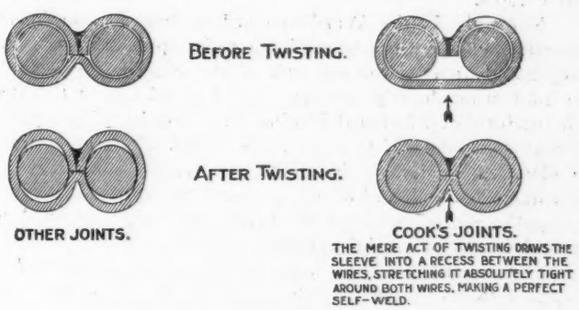
Brake Equipments.

For use on single cars and trains having not more than two trailers, Allis-Chalmers Company recommends straight air-brake apparatus, but for trains of over three cars in length automatic air-brake equipments are to be preferred.

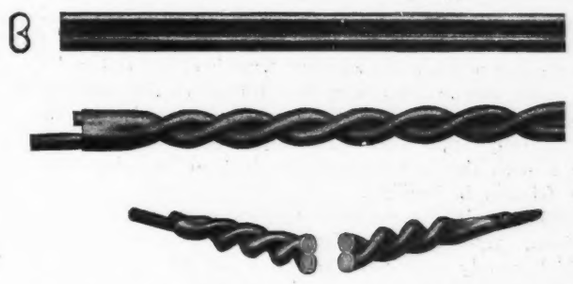
On a modern electric car, with the numerous devices now in use, economy of space is an item that must, of necessity, be considered, and the Christensen compressor is the most compact, self-contained unit of power now on the market. On account of its simplicity of construction, this compressor is easily accessible, thereby reducing the time consumed for repairs and inspection to a minimum. The time required to take the Christensen compressor apart is very much less than for any other compressor. This should appeal to the management of any electric railway system having a large number of equipments in service, as it means a very considerable saving in the cost of maintenance.

THE COOK SELF-WELDING WIRE JOINT.

Wire joints (or sleeves or connectors, as they are called) and their uses are so familiar to telephone men and to the trade in general that a lengthy description will not be necessary in introducing the Cook self-welding wire joint. The Cook joint, however, in its construction and application, differs radically from all other joints.


BEFORE TWISTING.
AFTER TWISTING.
OTHER JOINTS.
COOK'S JOINTS.
THE MERE ACT OF TWISTING DRAWS THE SLEEVE INTO A RECESS BETWEEN THE WIRES, STRETCHING IT ABSOLUTELY TIGHT AROUND BOTH WIRES, MAKING A PERFECT SELF-WELD.

In the old-style tubular joint, the tube is made to fit the wire as closely as possible. When the joint is twisted, the tube is not stretched around the wire, but is drawn close to some portions of it and bulges out at other portions, thus leaving a considerable part of the surface of the wire and the joint accessible to moisture and other atmospheric conditions.



The Cook joint is made with one side flat. The tube fits the wires closely, and when the joint is twisted, the flat side is forcibly and naturally drawn into the recess between the wires, stretching the joint absolutely tight around both wires. This makes practically a perfect cold weld joint, and it is impossible for moisture or air to penetrate the tube and corrode the wires or the inner surface of the joint. When the wires are inserted in the joint, twisted three times and the joint is then cut in two, it is almost impossible to discern the line where the inside of the joint and the outside of the wire come together. The tensile strength of the joint is much greater than that of the wire itself. Owing to the fact that the joint binds so tightly on the wire, it is unnecessary to turn back the end of the wire after it has been inserted through the tube.

No long, detailed instructions are necessary for the use of the Cook joint. Simply insert the wires and twist three complete turns to the right. Cook's self-welding wire joints are made of copper for copper wires, and of steel, heavily tinned, inside and out, for galvanized iron or steel wire. They are manufactured by Frank B. Cook, 233 West Lake Street, Chicago, Ill. Mr. Cook is represented on the Pacific Coast by Estes Electrical Company, of San Francisco, Los Angeles and Seattle.

NEW APPLICATION OF MULTIPLE VOLTAGE SYSTEM.

Applications of the well-known Ward Leonard Multiple Voltage System of variable speed control, have been made in numerous industries throughout the country, including cloth printing establishments, railroad shops, machine shops, and wherever variable speeds are required from motor-driven machine tools.

Not only is the Ward-Leonard system in use in this country, but in Europe as well, where its application has been fully as advanced as on this side of the water. For instance, an interesting description was recently read before the British Institute of Electrical Engineers, of the hoisting installation at the Zollern II Colliery in Germany, where use is made of electrical equipment involving the Ward-Leonard system of voltage control, and of an extremely heavy fly wheel. As no application of this kind has heretofore been described, we give the following brief outline:

The armatures of the hoisting motors are connected directly, without switches to the armature of a generator, the voltage of which can be varied at will, the field strength of the hoisting motors being maintained at a constant value.

The winding drum is driven by two direct-current motors, each of which is rated at 750 horsepower at 500 volts. These motors receive their power from a motor-generator, a description of which is given below. The whole of the starting, stopping, speed regulation and reversing is done by one switch, which operates a resistance placed in the shunt field circuit of the generator of the motor-generator set. By this means only currents of small magnitude are dealt with, the burning of contacts is avoided, and heavy and expensive resistances are not necessary. Practically no power is wasted in resistance when the winding drum is run at reduced speeds. A small amount of energy is returned to the motor-generator from the winding motors during retardation, and this is usefully applied in accelerating the enormous fly-wheel used with the motor-generator, instead of being consumed by friction in braking.

The main generating equipment consists of two engine-driven, 525-volt, 1,100-kilowatt, direct-current generators, which supply power to the whole of the machinery at the colliery. A single generator is sufficient to supply power to the electric hoisting equipment, the washery, fans, air compressors, work shops and pumps.

The most interesting part of the electrical installation is the motor-generator, referred to above. This machine is used to prevent abnormal fluctuations in the demand for power from the main generators. The starting of the winding drum would have necessitated a tremendous rush of current from the generators if the usual type of equipment had been employed. The motor-generator consists of a shunt-wound generator direct-connected to a 15-ton fly-wheel and a special variable voltage generator. The fly-wheel is of steel and runs at a peripheral speed of 14,000 feet per minute. It is placed between the two bearings of the set, the armature of the motor being mounted outside of the bearing, and that of the other outside of the other bearing. Although the motor is rated at only 300 effective horsepower, the generator has an output of 1,000 kilowatts when excited to full e. m. f. of 550 volts. The latter machine is specially designed. It is provided with a double commutator and a special field magnet, having auxiliary poles with series windings to prevent sparking. The main field coils are shunt-wound and are supplied with current from the main generators. By this means any desired e. m. f. is obtained for operating the hoisting motors.

The effectiveness of the motor-generator set in preventing fluctuations is shown from a series of tests reported by the author. Although the current taken by the hoisting motors during starting was 1,500 amperes, decreased to 1,000 amperes as the hoisting motors reached full speed, and became 500 amperes when the drum was brought to rest, the current taken from the main generators by the motor of the motor-generator set varied from 100 while the drum was being started, to 450 when the drum reached full speed and decreased to 0 when the drum was being brought to rest.

For the above information we are indebted to the Allis-Chalmers Company, of Milwaukee.

DISPOSAL OF COKE.

The question of the disposal of the coke is an important one, seeing that every ton of coal carbonized for gas yields some 10 or 12 cwt. of coke over and above the quantity required for heating the retorts. If the whole of this coke had to be conveyed to the markets where it now finds a sale, there would be little or no gain from doing away with the carriage of the coal; but, fortunately, a large demand for coke already exists at no great distance from the coal fields. At the present time some 12,000,000 tons of coke are made every year for use in the manufacture of iron and steel, and in the case of no less than 11,000,000 tons the whole of the gas and other residuals is wasted. This enormous waste may be prevented by the use of by-product recovery ovens, in which in actual practice a ton of coal of medium volatility, which could not be fairly classed as a gas coal, is reported to have yielded over 10,000 cubic feet of first-rate gas, which is well up to the usual output from gas coals.

It may be noted here that the coke made in the ordinary gas retort is not suitable for foundry use, the carbonization not being continued long enough to produce coke of the required quality. In gas manufacture a system of quick carbonization and frequent charges is adopted with a view to economy; but if longer periods are economically practicable where coke alone is produced, it seems obvious that they may be used with at least equal advantage where the gas as well as the coke is utilized. As a matter of fact, several American cities already derive their supply of gas from by-product coke ovens, which even from a gas manufacturing point of view are claimed to have important advantages over the old-fashioned retorts.

If all the foundry coke which is used in England were made in by-product recovery ovens, the resulting yield of gas would be over 160,000,000,000 cubic feet per annum, or more than is used in one year in the whole of the United Kingdom. If, however, gas is to take the place of coal for all domestic and most industrial uses, the consumption will probably be quadrupled and the problem of coke disposal reappears.

A large quantity of coke will be required for heating the ovens, and the generation of steam for the compressing plant, and much of it may with advantage be employed to take the place of the coal which is now used for various purposes at the collieries. Moreover, the yield of coke may be greatly reduced, and an outlet found for it at the same time, by manufacturing water gas in lieu of part of the coal gas.

CEMENT-COVERED TELEGRAPH POLES.

Experiments which were made in India some three years ago in covering wooden telegraph poles with cement, put on in a thick coat over wire netting securely fastened to the pole, are said to have been satisfactory, and to have afforded absolute protection against that pest of tropical countries, the white ant.

Evidently the numerous branches of the H. W. Johns-Manville Company are inadequate to properly supply the demand for its asbestos and magnesia products and electrical devices. On January 1st a branch, consisting of a large retail store, offices and warerooms in the large three-story building located at the corner of Baronne and Perdido Sts. Mr. W. E. Carpenter, formerly local manager of the Western Tube Company, will have charge of this branch.

AN EXTENSIBLE TELEPHONE BRACKET.

The complexity of modern business life is keeping many thoughtful men at work devising ways and means to facilitate the transaction of business with the greatest dispatch and certainty. The telephone is not the least of the time-saving devices found in the business office, but, like an officious servant, it is frequently in the way when not needed, unless it is mounted on some such contrivance as the Burns' Adjustable Telephone Holder and Extensible Bracket. This bracket is constructed on the well-known principle of the pantagraph,

and may therefore be lengthened and shortened without disturbing the rigidity of the support. To properly decrease the sliding friction of the guides, they are fitted with fiber bushing carefully boiled in paraffine. The bracket is capable of a swinging motion about the vertical supporting rod. A special combination bracket is also made which will accommodate two telephones. Both of these types are sold by the Estes Electrical Company, 604 Mission street, San Francisco.

RECENT WESTINGHOUSE-PARSONS TURBINE SALES.

Hunt, Mirk & Co., Inc., of San Francisco, who are the Pacific Coast agents for the Westinghouse Machine Company, report the following sales in Southern California:

One 300-kilowatt Westinghouse-Parsons steam turbine unit, together with piping and auxiliary apparatus, for the Merchants' Mutual Electric Light & Power Company, Santa Barbara.

Two 500-kilowatt Westinghouse-Parsons steam turbine units, surface condensing equipment, engine-driven exciter units, boilers, etc., for the power plant of the San Diego Electric Railway Company; also a 500-kilowatt motor-generator set and other apparatus for a new sub-station for the same company. The additional equipment for the power plant will furnish current for the 32 miles of road now under construction, which will probably be in operation within six months.

The Electric Storage Battery Company, of Philadelphia, manufacturers of the "Chloride Accumulator," has installed four of the eight sub-station batteries contracted for by the New York Central & Hudson River R. R. Co., for use in connection with the electrification of the New York Terminal.

The batteries now in operation are located respectively at Bronx Park, King's Bridge, Mott Haven and Fiftieth Street.

The eight sub-station batteries will have a total capacity of 60,000 horsepower.

One of the two Exciter Batteries contracted for by the same company has also been installed at Port Morris.

ANOTHER ADVANTAGE OF ELECTRICAL MACHINERY.

A novel method of ascertaining the efficiency of employes, which is made possible by the use of electrically-driven machinery, has been introduced in the works of the Firth-Sterling Company. It consists of placing in a convenient location for observation a recording ammeter, arranged to be connected in circuit with any machine whenever desired. Previous tests have determined approximately the current required for a given class of work, so that the record of the ammeter indicates whether or not the machine is working up to its capacity and the time it stands idle. In another works where this was tried it was found that, aside from the question of the efficiency of employes, the curves obtained afforded a means of locating weak spots in setting the work in place and handling it to and from the machine. Very often the actual time the machine was in operation was a surprisingly small percentage of the working day, and by following up instances of this kind it was possible to considerably improve the output.

POWER PLANT AUXILIARY EQUIPMENT.

In a lecture before the National Association of Stationary Engineers, Illinois No. 1, of Chicago, delivered on Wednesday evening, November 21st, Mr. R. D. Tomlinson, past national president of the association and condenser expert of the Allis-Chalmers Company, Milwaukee, dealt vigorously and at some length with a subject on which there has arisen of late a good deal of discussion. Mr. Tomlinson, whose knowledge at first hand of all of the latest improvements in the mechanical engineering field, and especially in relation to the auxiliary equipment of modern power stations, fitted him to talk convincingly, emphasized one or two points rather strikingly.

All machinery outside of boilers, main engines and generators, was classed as auxiliary apparatus, and, according to Mr. Tomlinson, the two features to be obtained from that equipment are, first, reliability, then efficiency; for a shutdown, even for a short time, causes material loss. Some auxiliaries are necessary for all plants; the question to decide is what apparatus will be sufficient to make the plant efficient without undue complication.

The speaker criticized, in particular, the common use for various purposes in the power plant of a large number of direct-acting pumps, consuming from 60 to 300 or more pounds of steam per horsepower, depending upon the mechanical condition of the pumps and the conditions under which they are operating. The majority of the direct-acting pumps in use are "short stroking."

Within the past few years there has been developed to the highest state of efficiency a line of compound horizontal crank and fly wheel pumping engines, with Corliss liberating valve gear, of a capacity from three-quarters of a million to five million gallons, and in a vertical type from one-half a million to five million gallons daily capacity, especially suited for elevator service and work of a similar nature. The builders, Allis-Chalmers Company, guarantee a saving of fuel for equal work of at least 40 per cent over the type of direct-acting pumps now in general use in office buildings.

The main reason for the installation of the direct-acting type of pump is the small floor space which it occupies and low first cost, but when the enormous saving in fuel is considered and the fact that boiler capacity can be reduced in accordance with the reduction in steam consumption, the power user can well afford a little more floor space and to pay the difference in price.

SOME FEATURES OF THE NEW NATIONAL MOTOR COMPRESSORS.

Recently the National Brake & Electric Co., of Milwaukee, has developed and is now manufacturing new types of motor compressors, of which the most frequently used for street railway service are the A-4 and BB-2 types. These motor compressors represent many advanced ideas in design and construction, and are built according to the suggestions of some of the foremost master mechanics and street railway officials, modifid by the long experience of the air-brake experts of this company.

One of their many distinctive features is the construction of motor and compressor as entirely separate and self-contained units. When the two parts are assembled a very compact and rigid compressor unit is produced. In Fig. 1 is shown a complete A-4 type compressor. The crank chamber cover and motor base are separated by a ½-inch air space, as shown in the illustration. The motion of the car causes a strong current of air to circulate through this space, thus rapidly sweeping away the heated air. This feature greatly conduces to low-temperature operation. The separate cover gives the required bracing and stiffening for the crank chamber casting.

Though a box covering for motor compressors tends to keep them free from accumulating dust, the colling air currents are prevented from flowing and there is a consequent reduction in efficiency of about 25 per cent. In the partially enclosed new National compressors this expensive disadvantage is absent and there is, therefore. a material saving in power. The operating parts are constantly exposed to the atmosphere and may be radily cleaned with a jet of water.

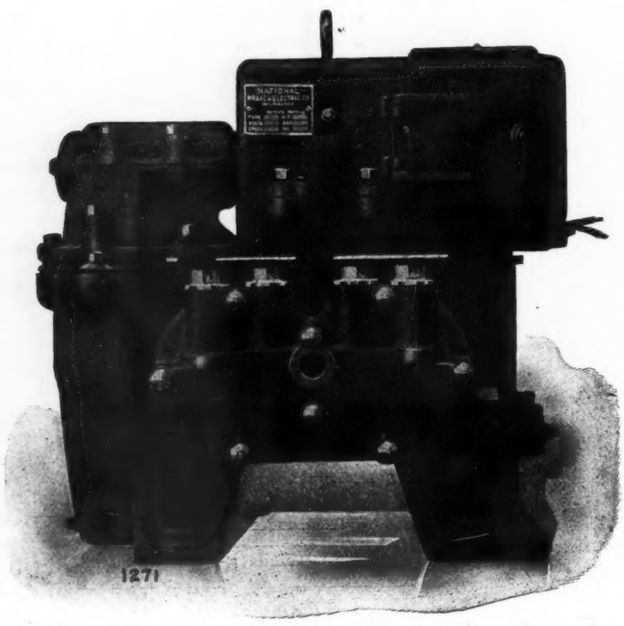


FIG. 1—TYPE H—COMPRESSOR OF THE NATIONAL BRAKE AND ELECTRIC CO.

The simplicity of design and construction of the compressor is admirably shown in the phantom view, Fig. 2. It will be noticed that the crank shaft is fitted with a third bearing (2) in its center, which, in addition to supporting and strengthening it at the weakest point, eliminates all tendency of the shaft to fracture at the center. This third bearing also makes the operation of the compressor much quieter and gives greater freedom from vibration than is the case with two bearing compressors. Thus the life of the pump and gearing and their efficiency is greatly increased. Removal of crank shaft and gear is accomplished by lifting them srtaight out of the crank chamber. The removal of the gear from the shaft, which must be done on most compressors before the crank shaft can be dismantled, is entirely unnecessary; thus greater accessibility to the pump is gained and the minimum time consumed in dismantling and reassembling the parts. The splash system of oiling is used, the gear and crank running contsantly in a bath of oil which is splashed

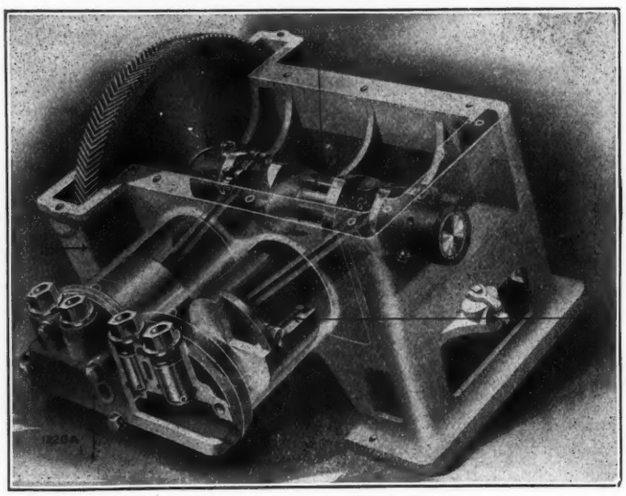


FIG. 2—PHANTOM VIEW OF THE NATIONAL MOTOR COMPRESSOR.

over all the operating parts of the compressor. It will be noticed that the gear case (1) is constructed as an integral part of the crank case, instead of being cast separately. Such construction makes a highly rigid pump base, reduces the number of loose parts and unsightly bolts and does not necessitate draining the oil from the gear case and crank chamber for inspection of these parts.

The valve head is constructed with discharge valves towards the center, and the suction valves towards the outside of the head. The valves are of the solid cold-drawn tubular steel type, and are perfectly interchangeable. They are held by gravity aided by air pressure; no spring or auxiliary device, which constantly gives trouble, is employed. The discharge pipe runs straight out of the valve head to the main reservoir, thus dispensing with the necessity of attacihng unsightly elbows and goose necks. Both gear and pinion are of the standard herringbone pattern and are cut with great accuracy.

The motor of the compressor outfit is a standard four-pole machine, entirely enclosed, and designed with an unusual liberal rating and with a view to great accessibility. One of the many distinctive features of the motor is the heavy insulation employed in the brush gear. The brush gear on many compressors is the weakest and most troublesome part, due to the fact that many manufacturers only provide from three-eights to one-half of an inch external leakage surface in insulation, and the accumulation of oil and dust frequently results in complete break-downs by the current eating through the bushing or creeping over the small oil-covered surface. The thickness of the insulation used on National motor compressor brush gear is one and one-fourth inches, which gives assurance that no such contingencies will occur.

In Austria the following denaturing process is employed for alcohol for motor use: To 100 liters of absolute alcohol, 5 liters of benzine are added, one-half liter ketonic oil or pyridine, 0.2 grams methyl violet dissolved in 20 cubic centimeters of alcohol.

News Notes

TELEPHONES AND TELEGRAPH.

Columbia City, Wn.—The Citizens' Tel. Co. has passed into the hands of the Independent Tel. Co., of Seattle, with E. A. March, manager. A 100-line trunk cable will be strung to Seattle at once. The line will be extended to Renton.

Ellensburg, Wn.—The Pacific States Tel. & Tel. Co. will begin, January 1, installing an up-to-date exchange.

Mount Vernon, Wn.—Robt. C. Young, of the Sunset Tel. & Tel. Co., is here making a preliminary survey of the local field with a view to building an entirely new plant.

Pomeroy, Wn.—The Chord Tel. Co. has its line completed and is installing phones.

Seattle.—The Board of Public Works granted permission to the Independent Tel. Co. to install a 3-inch iron conduit on Railroad Ave. from Madison St. to Virginia.

Seattle.—Admiral Burwell plans to install a wireless apparatus here to afford direct communication from Seattle pay office to Mare Island.

Sheridan, Wyo.—It is reported that the Lovell telephone line is to be extended to include the towns of Dietz, Carneyville, Monarch, Ranchester, Dayton, Cloverly, Shell Coburn, Crystal Kane and Iona. Ira Waters, of Lowell, is manager.

Washington, D. C.—It is proposed to extend the duplex now working between Seattle ad Sitka to the Sitka-Valdez section.

Kuipp, Wn.—The local telephone company, which has a line to Odessa, will shortly be connected with the Pacific States Tel. Co. at that point.

Lewiston, Ida.—F. A. Uhrich, manager of the Pacific States Tel. Co., states the new line between this place and Grangeville will be in operation January 1st. The switchboard at Grangeville is being remodeled. The company will also build a line between here and Silcett.

Maple Falls, Wn.—The Maple Falls Tel. Co. has decided to begin work on its pole line at once.

Seattle.—The Sunset Tel. Co. was granted permission to install a number of conduits and poles on Second Ave. N.

Seattle—The cableship Burnside, now at Juneau, A., will repair the Juneau-Skagway cable.

Weston, Ore.—The various rural telephone companies centering at this place have joined in a petition for a franchise for 10 years for rights of way.

Woodland, Wn.—The Lewis River Independent Tel. Co. has been incorporated with $5,000 capital by R. D. Lawson, J. S. Fields and J. W. Strong.

POWER AND LIGHT PLANTS.

Anacortes, Wn.—A. F. Bast, of Everett, is setting a 150-horsepower boiler for the Anacortes Electric Light Co. The company also has plans for installing two more boilers and a powerful dynamo.

Anaconda, Mont.—Another big power plant is planned for the upper Madison river by the Madison Power Co., and the electricity generated will be brought to Butte. The pole line will be 150 miles in length.

Boise, Ida.—I. B. Perrine states that contract has been let to W. H. Barry for the completion of the power plant at Shoshone Falls. A transforming house is to be built in Twin Falls.

San Francisco.—The Board of Works yesterday rescinded its action of last week and granted the Van Ness Avenue Retailers' Association a temporary permit to install sixty ornamental poles with two arc lights each upon four by eight foot safety stations down the middle of the avenue from Market street to Pacific avenue.

Eureka.—Plans and specifications are now being drawn in San Francisco by Architect Henry Myers for new gas works in this city. The present plant of the Eureka Lighting Company on H street has been found too small for the rapid increase in the consumption of gas. The new plant will be located on land adjoining the site of station B, at the foot of Whipple street, and the present works will, upon its completion, be abandoned. The new gas station will be a building of steel frame, covered with corrugated iron, 23 feet high, 40 feet wide and 65 feet long. Two gas generators, each 9x12 ft. in diameter, with a super-heater 6x24 ft. high will produce 400,000 feet of gas daily. It will take a mile of 8-inch pipe to connect the new works with the present system supplying the city. The cost of the improvements will total $26,000, and the greater part of this sum will be spent here. Langford Bros. are now putting in a 200-horsepower water tube boiler for the Eureka Lighting Company at station B. Another 250-horsepower engine will be installed.

Chihuahua, Mex.—The Parral Gas Company, capitalized at $1,000,000, has been formed by Dr. H. F. Thompson of Kansas City, who has secured a state concession. Associated with him are P. Keays of El Paso, A. N. Daguerre, W. E. Brock and Victor Esperon. Enough money has been subscribed to erect the plant, and the work of laying mains will be started as soon as the sewer and water systems are installed.

Yuma, Ariz.—The City Council has passed an ordinance calling an election on January 4th, 1907, to vote on the question of granting a gas franchise to Seth Hartley to erect, maintain and operate a gas plant and distributing system in Yuma.

Fortuna, Cal.—J. E. Dowd, lessee of the Capetown hotel, store, blacksmith shop and ranch, has recently re-leased the property to L. P. Branstetter for a term of eight years. Mr. Dowd will at once install an acetylene gas plant to illuminate his hotel, store and new dance hall.

Los Angeles, Cal.—At a meeting of the Fire Commissioners the board decided to continue the application of the People's Gas Company for a permit to install three boilers in their works on St. John street.

Redlands, Cal.—At a meeting of the Board of Trustees the application for a gas and electric franchise petitioned for by Walter M. Campbell, attorney, and F. P. Meserve, president of the Home Telephone Company, was granted, and the franchise will be offered for sale.

Lodi, Cal.—F. Boardman of Berkeley, H. C. Keys and F. B. Smith of Sacramento and P. B. Fraser of Stockton purchased a lot from F. W. Beckman for the purpose of manufacturing gas for the supply of the town. The pipe has been shipped from the East and will arrive in a few months.

Riverside, Cal.—The City Trustees have signed a contract with the Pacific Light and Power Company and the Edison Electric Company to supply the city with electrical energy for ten years. It was further agreed between the city and the Edison Company that all the electrical apparatus installed by the city in the power company's power house in Mill Creek canyon and the transmission line built by the city be conveyed and sold to the Edison Company for $12,000. Agreement between the city and the Pacific Light and Power Company provides that the power company will connect the lines of the plant installed by the old Riverside Power Company with lines of the balance of the system of the Pacific Light and Power Company; also that the power company will install certain pieces of electrical apparatus, some of which will be for the purpose of measuring the current. The contract with the Pacific Power Company covers five years.

Saltillo, Mex.—Entirely new machinery is shortly to be added to the Saltillo electric light plant, which will be of the latest pattern and of large capacity.

POWER AND LIGHT PLANTS.

Boise, Ida.—Guy C. Barnum, of Shoshone, has sold his interest in Thousand Springs Land & Transportation Co. to A. M. Harris. The company is building a power plant in Lincoln county that will develop 12,000 horsepower.

Portland.—The Gordon Mfg., Power & Light Co. has incorporated with a capital of $175,000. Sigmund Sichel is one of the incorporators.

Roseburg, Ore.—The Myrtle Creek Water, Light & Milling Co. was incorporated with a capital of $20,000 by C. O. White, T. R. Sheridan and M. A. Kelsay.

Tacoma.—The Tacoma Industrial Co. (J. V. Thompson, superintendent), is extending its lighting wires throughout the city. The Maplewood and Meeker Junction districts are to be furnished with electric light.

Vancouver, Wn.—The Washington Railway & Power Co. has been incorporated with capital of $150,000 by Walter H. Moore, Arthur Langguth, H. C. P. Phillips, A. L. Miller and Lester B. French.

Pasadena.—Judge James of Los Angeles has handed down the decision in the case of some sixty taxpayers against the municipality to restrain the city from spending $65,000 of the tax fund for construction of an electric municipal plant in favor of the city. Some months ago the city voted bonds for construction of such a plant, but the Edison Company tied them up in the courts. Contracts for the electrical machinery have been let.

Los Angeles, Cal.—The Board of Fire Commissioners granted permit to the People's Gas and Coke Company to erect a plant on St. John street.

Prescott, Ariz.—A petition for a franchise to erect an electric light plant for this city has been presented to the council by Ray Hill, George C. Ruffner and M. J. Hickey. If the petition is granted a stock company will be formed. The council approves the granting of the franchise, and it will be submitted to the people at the general election January 8th.

Dawson, Y. T.—The preliminary survey for the power line of the Fuller Grant line between Coal Creek and this place is being run by Garrett Tyrrell and party. The company plans to install its large power plant at Coal Creek next season.

Ellensburg, Wn.—City engineer was instructed to make a survey and estimate of cost for extending the electric light canal to make the intake a mile further up the river.

Falls City, Ore.—Council has granted the Northwestern Guarantee & Trust Co. a franchise to erect and maintain an electric power plant here.

Grace, Ida.—The Telluride Power Co., of Salt Lake City, has decided to construct a power plant at this place to cost $1,000,000.

Kennewick, Wn.—Howard Amon has filed on 11,000 cubic feet of water to be taken from the Snake River, five miles east of Pasco. 20,000 horsepower will be developed.

North Yakima.—Council has ordered 36 additional arc lights installed and a 32-candlepower light placed at every ditch crossing in the city.

Prineville, Ore.—The Pringle Falls Electric Power & Water Co. has incorporated with $1,000,000 by O. M. Pringle, J. W. Collins, W. H. Huston and L. B. LaFollett. Company will supply light, power and water to this city.

Portland.—The Portland General Electric Co. has been granted a franchise for a steam heating plant. The cost of the plant will be about $300,000.

Wallace, Ida.—It is reported that the Thompson Falls water power has been bought by Ed. Donnelly, of Montana, for the Greenough interests.

ELECTRIC RAILWAYS.

Bellingham.—The Whatcom County Ry. & Light Co. is extending their car line on Garden St.

Seattle.—Council granted franchise to S. E. Co. for street railways on 10th Ave. et al., 31st Ave. et al. and Summit Ave. et al.

Spokane.—The Okonogan Electric Ry. Co. has been incorporated with a capital of $3,000,000 by A. M. Dewey, M. L. Bevis, L. K. Armstrong and others. The company proposes to build an electric railway from 19th to Loomis.

Spokane.—The Spokane Pen d'Oreille Rapid Transit Co. has applied for franchise to construct a loop two blocks long and one and one-half blocks wide.

Tacoma.—Work is to be rushed on the new interurban line between Tacoma and Puyallup, Sumner and Orting, by the T. R. & P. Co.

Walla Walla.—The Walla Walla Valley Traction Co. will erect a brick car barn and machine shops near the military reserve to cost $7,500.

Wallace, Ida.—W. J. Hall was granted a 50-year franchise for a street railway system.

Everett, Wn.—The Everett Street Ry. Co. has begun the construction of a new line north on Rucker Ave. from 19th out to 13th.

Freewater, Ore.—Council has granted a franchise to the Walla Walla Valley Traction Co. for an electric line on Robin Street.

North Yakima.—T. A. Noble, Frederick Elmendorf and others have applied to county commissioners for franchise to build and operate an electric road along certain county roads.

Portland.—S. B. Cobb secured the passage of an ordinance transferring the franchise of the Mount Hood Electric Co. to the Mount Hood Power & Railway Co.

Spokane.—It is reported that the Spokane & Inland has awarded to Grant Smith & Co. the grading contract for a 15-mile extension from Palouse, Wn., to Moscow, Ida. The line will be extended to Lewiston and Clarkston next season.

Snohomish, Wn.—Superintendent C. A. Banon has received instructions to begin construction work at once on the Snohomish Valley Ry.

Butte, Mont.—The Butte Electric Ry. Co. will in the spring extend its South Butte line to the new Gallitin addition.

Seattle.—Plans for laying a double track on Westlake Ave. by the Seattle Electric Co. were approved by the Board of Public Works.

Victoria, B. C.—The B. C. Electric Ry. Co. plans numerous extensions to their system in the business section of the City.

Coeur d'Alene, Ida.—J. K. Ashley states that construction work will be commenced in the spring on the proposed electric line between Wallace and Spokane.

Chewelah, Wash.—Manager Wolffe of the United Copper Company is here from Spokane with a crew to make the survey for the proposed electric line to the company's mines.

Forest Grove, Ore.—An electric line from Portland to this place is contemplated by the Oregon Electric Company.

Hoquiam, Wash.—The Grays Harbor & Puget Sound Railway Company has applied to the council for a right of way through the city.

New Westminster, B. C.—The C. P. R. surveyors have commenced surveying for the new line to be built between Eburne and this place. When completed it will be operated electrically by the British Columbia Electric Railway Company.

Seattle.—The Seattle, Renton & Southern Railway Company has presented an amended franchise application to the city council.

Tacoma.—E. J. Felt of the Pacific Traction Company states that work will be commenced at once on the line to South Tacoma.